United States
Department of
Agriculture

Forest Service

**Northeastern Area
State and Private
Forestry**

December 2002

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New York – New Jersey Highlands Regional Study: 2002 Update

Stewardship Goals for the New York – New Jersey Highlands

This 2002 Update of the 1992 New York – New Jersey Highlands Regional Study embodies the following goals for the long-term stewardship of the Highlands:

1. **Manage future growth that is compatible with the region's ecological constraints;**
2. **Maintain an adequate surface and ground water supply that meets the needs of local and downstream users;**
3. **Conserve contiguous forests using management practices that are consistent with private property rights and regional resources;**
4. **Provide appropriate recreational opportunities; and**
5. **Promote economic prosperity that is compatible with goals 1-4.**

New York – New Jersey Highlands Regional Study: 2002 Update

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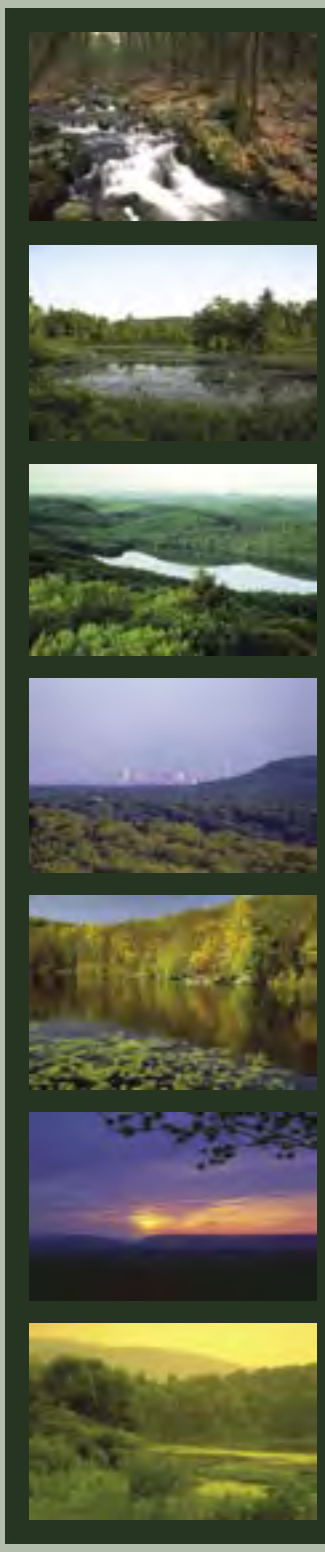

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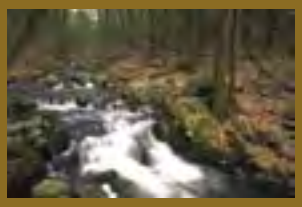

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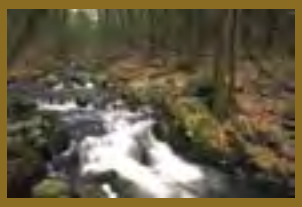

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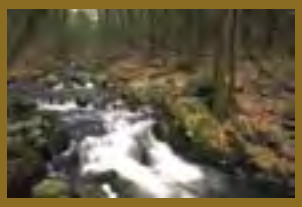

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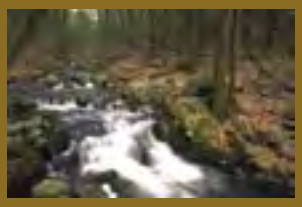

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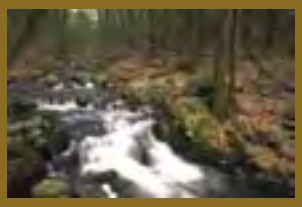

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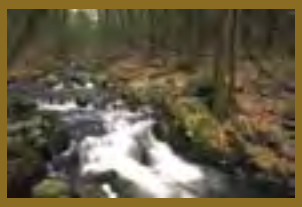

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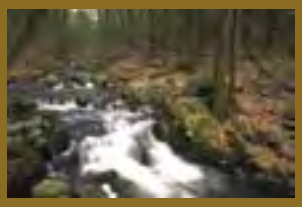

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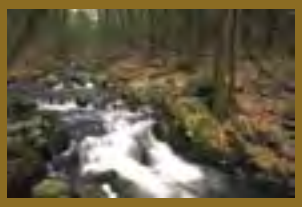

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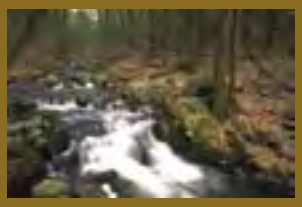

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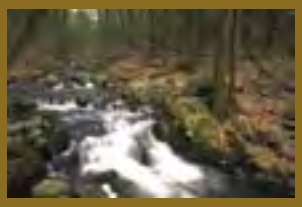

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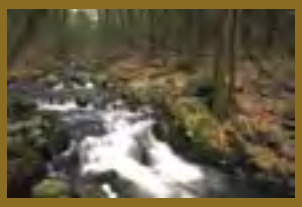

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All photographs are by George M. Aronson and are used by permission.

The New York – New Jersey Highlands Regional Study: 2002 Update was accomplished through the cooperation of Federal, State and university natural resource specialists. Logos of the agencies and organizations involved in the study update are displayed below.

US Department of Agriculture Forest Service

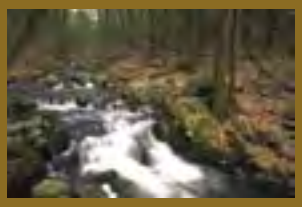
Regional Plan Association

Grant F. Walton Center for Remote Sensing and Spatial Analysis

US Geological Survey

New York State Department of Environmental Conservation

New Jersey Division of Parks and Forestry



Section 1 Introduction

Photograph by George M. Aronson

The public vision for the future of the Highlands region is that it remain an oasis of open land that can provide a sustained quality of life and environmental integrity…

Preamble, 1992 New York – New Jersey Highlands Regional Study

Section 1 Introduction

Background

One in nine Americans lives within a 2-hour drive of the Highlands; and its abundant natural and cultural resources provide quality drinking water, recreation, and economic opportunities for millions in the region and in the New York – New Jersey metropolitan area. The initial study of the New York – New Jersey Highlands (Michaels and others 1992) described the area as one of national significance. The study called for the protection of the Highlands as a greenbelt because the forests and farms were at risk of being changed by a growing population, urban decline, and suburban sprawl. These projected changes were likely to adversely affect drinking water quality, wildlife habitat, recreation opportunities, the agriculture and forest products industries, and historic and cultural sites.

The 1992 study report presented an alternative vision for the Highlands that could be achieved by assisting private landowners in managing their natural resources, helping communities manage growth, and preserving the most critical watersheds, wildlife habitats, and forest areas. The report identified conservation strategies, based on the following goals:

1. Manage future growth;
2. Maintain an adequate supply of quality water;
3. Conserve contiguous forests;
4. Provide appropriate recreational opportunities; and
5. Promote economic prosperity that is compatible with goals 1-4.

Various public and private entities have taken actions to achieve the vision and goals that were formulated for the Highlands. Although no specific Federal designation has been provided for the Highlands, agencies have worked within available authorities and guidelines to provide technical and financial assistance to conserve and protect critical resources. State and local interest in the region has increased, and organizations have undertaken new efforts to protect and sustain the region's forests and farmlands.

Conservation Successes Since 1992

Since the 1992 study was published, a number of steps have been taken to protect land and resources in the Highlands (for more information, see Appendix J):

1. Emphasizing land protection through acquisition of land or conservation easements—20,000 acres protected in Sterling Forest;
2. Utilizing the USDA Forest Service's Forest Legacy Program—2,600 acres protected in New Jersey, and 847 acres protected in New York;
3. Increasing State, county, local, and private sector support for open space acquisition—80,000 acres protected in New Jersey, and 100 projects completed in New York;
4. Implementing measures to protect drinking water supplies—18,100 acres protected by New Jersey, and the 1997 New York City Watershed Memorandum of Understanding adopted;
5. Implementing greenway projects—Hudson River Valley Greenway established;
6. Increasing support for watershed-based assessment and planning—20 watershed management areas studied in New Jersey;
7. Improving availability of regional resource data—the Treasures of the Highlands report was released;
8. Increasing awareness of sustainability and sustainable development—Highlands designated as a special resource area in the New Jersey State Plan;
9. Preserving farmland—more than 16,000 acres protected;
10. Recognizing the Highlands' ecological importance—Highlands designated as a unique physiographic region in the New York State Open Space Plan.

Need to Update the 1992 Study

Despite the successes and accomplishments in resource conservation since publication of the 1992 Highlands study, population in the region has grown significantly, and land-consuming growth patterns have continued. The population of the 108 municipalities in the Highlands region of New York and New Jersey was 1.4 million in 2000. This represents an 11.5 percent increase since 1990. Land-use change in the region is particularly evident in the decreasing number of large working farms, the increased number of large-lot residential subdivisions, and increased deforestation. The completion of Interstate Highway 287 through northern Bergen County, New Jersey, into Rockland County, New York, created a major new transportation corridor that has spurred additional commercial and residential development in the surrounding communities. Other major regional land-use changes are visible along the Interstate Highway 80 and Interstate Highway 78 corridors in New Jersey, in portions of Orange County in New York, and the area north of New York City.

STUDY AREA

Changes in land use and land cover in the region continue to be significant and have the potential to affect the environmental and economic factors that sustain a high quality of life. In October 2000, Public Law 106-291 authorized and funded an updated study of the New York and New Jersey Highlands under Section 1244(b) of the Food, Agriculture, Conservation, and Trade Act of 1990 (104 Stat. 3547). Congress appropriated $750,000 for this purpose in Fiscal Year 2001 (Appendix A).

The purpose of this study update is to…

1. Reassess the condition of natural resources in the Highlands region;
2. Analyze land cover change and potential land use;
3. Identify significant areas to be conserved and protected; and
4. Develop strategies to protect the long-term integrity of the region.

This update was guided by the 1992 study in regard to the vision and goals for the Highlands region. The resource assessment and subsequent analyses were expanded, however, taking advantage of the availability of spatial data and improved analytical techniques using Geographic Information System (GIS) technology. GIS allowed for more specific identification of significant land areas in need of protection and provided a more detailed description of future change than were identified in the earlier study.

The Highlands region will continue to face growth pressures if people continue to move out of major population centers into rural and suburban communities. A regional planning approach to coordinate ongoing planning efforts in the Highlands does not formally exist, but recognizing the resources and their geographic scope in the Highlands will assist in finding a proper balance between economic and housing demands, and environmental stewardship. This study update suggests several strategies that might be implemented by Federal, State, and local entities, private organizations, private citizens, and landowners, to protect priority conservation areas while permitting compatible development.

STUDY AREA

The study team adopted the Highlands study area boundaries from the 1992 study and expanded them from the Hudson River eastward to the New York–Connecticut border using topography and geology as key determinants (Figure 1-1). The landscape of the study area is characterized by a series of open high hills and ridges cut by deep narrow valleys that distinguish it from the surrounding rolling plains. The majority of the land is part of a geomorphic province called the Reading Prong, which stretches from northwestern Connecticut across the lower Hudson River Valley and northern New Jersey into east-central Pennsylvania (Van Diver 1992). Jurisdictional realities also

Figure 1-1. Highlands study area. The study area for the 2002 update of the Highlands regional study—which encompasses 12 counties in New York and New Jersey—extends the 1992 study area eastward to the Connecticut border, following topography and geology in the north and south directions.

played a part in setting the study area boundaries. In addition to the forested land of the physiographic region, the study area also includes some less developed and agricultural lands. The study area is comprised of 108 municipalities in 12 counties (Appendix B). An entire municipality was included in the study area even if only a portion of it fell within the Highlands physiographic boundary.

The boundaries of the study area could be revised again in the future, as more information is gained about the diverse ecosystems of the Highlands. For example, during implementation of the conservation strategies suggested in this report, the official boundaries could logically be extended to include the contiguous, ecologically similar areas (Figure 1-2) identified through a process known as ecological classification and mapping. Implementation could also be extended to ecologically similar areas in Pennsylvania and Connecticut. More information on ecological mapping is provided in Appendix C.

The current study area encompasses approximately 1.5 million acres of Appalachian ridges and valleys and stretches from the Lower Hudson River Valley in New York to the Delaware River in New Jersey. The area has these attributes:

- The total population is 1.4 million people.
- The Highlands adjoin the Nation's largest metropolitan area with a population of more than 20 million people.
- More than 11 million people are affected by Highlands water resources.
- Approximately 14 million people visit the Highlands each year for recreational opportunities in State parks and forest lands in 3 of the 12 counties.
- More than 240 species of birds, mammals, amphibians, and reptiles live, breed, or nest in the Highlands.
- More than 160 historical and cultural sites have been identified.

STUDY PROCESS

The study was coordinated by the USDA Forest Service, Northeastern Area State and Private Forestry, and was carried out in cooperation with the State Foresters of New York and New Jersey, with Rutgers University, the U.S. Geological Survey, and the Regional Plan Association. As a direct result of the Congressional appropriation, the Forest Service was able to fund various components of the study, including planning assistance, linkage among study participants, and public outreach and involvement. The study plan and budget are given in Appendix D.

A 14-person study team guided the process and provided the technical services and skills needed to conduct the study and prepare the report. Members of the

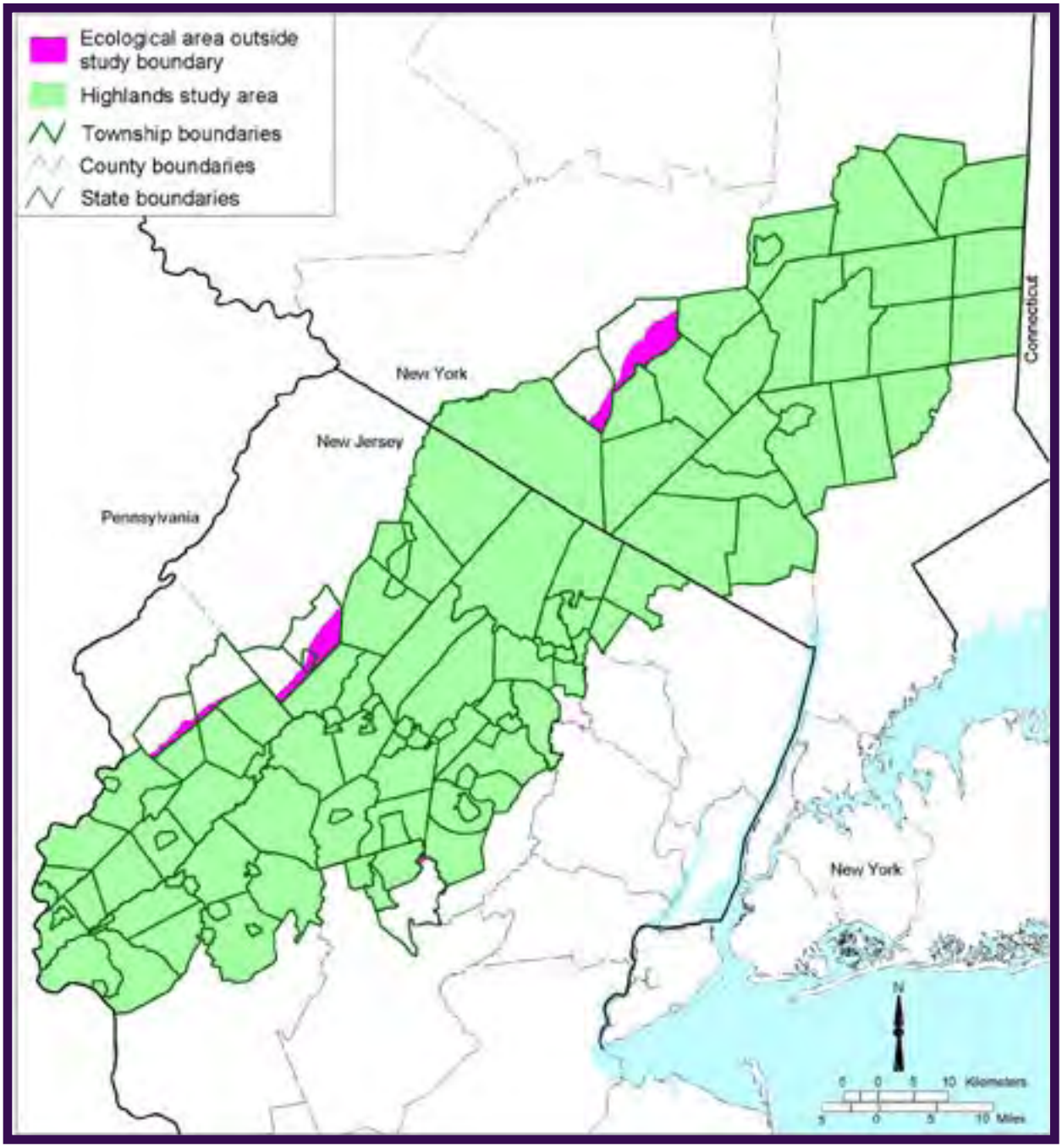


Figure 1-2. Areas ecologically similar to the study area. Adjacent areas that are ecologically similar to the Highlands study area were identified during the study update. Such complete ecological units provide a framework for ecosystem research and management.

study team frequently communicated and shared information about the status of the resource assessment, mapping, and analyses. A 120-person work group was established including individuals from both New York and New Jersey, who represented a range of resource interests. Work group members ensured a regional perspective, guided the study process, and commented on draft material as potential users of the study results. Study team members are listed in Appendix E, and work group members are listed in Appendix F.

PRE-DRAFT INPUT

Five work group meetings and four public listening sessions were conducted during 2001-2002, to develop and refine the scope of the resource assessment and to obtain community and public input. Forty to fifty people attended each work group meeting, including Congressional delegations from New York and New Jersey; and representatives from Federal, State, county, and local agencies, nonprofit groups, and the building community. Meeting minutes, including responses to comments received during the meetings, were prepared and distributed to work group members and interested individuals.

The public was encouraged to attend four listening sessions that were held throughout the Highlands Region in cooperation with the Regional Plan Association. Listening sessions were held in Cold Spring and Bear Mountain, New York; and in Oxford and Mahwah, New Jersey, in May 2001. These sessions were designed to provide an overview of the study components and to obtain comments from the public. Session attendees were asked to fill out a Highlands information sheet that contained these questions concerning the resource assessment:

- What are the natural resources important to the Highlands?
- Where are these resources located?
- How will these resources change in the future?
- How can we measure the impacts of these expected changes?
- Where are the natural resource conservation priority areas?

The information sheet was also mailed out to every local government in the Highlands and posted on the project Web site. Approximately 90 responses were received. This information was used to refine the scope of the assessment, specifically to determine which resources to map in the Geographic Information System and what values to place on those resources.

A Web site was established at http://www.fs.fed.us/na/highlands, to provide access to information on the Highlands in general, the 1992 study, and this study update. Local newspapers and newsletters from local environmental organizations also provided information to the public throughout the study process.

In March 2002, before the official release of the draft report, two newspaper articles appeared in the New York Times (Metro Section) and The Record (Bergen County, NJ).

INPUT ON DRAFT REPORT

The draft report was released in early April 2002. Four hundred copies were mailed to key stakeholders in the Highlands region, including Congressional representatives, local elected officials, members of the work group, county public libraries, and interested citizens. The draft was also made available online. The Highlands Web site enabled members of the public to view the information on their own and to submit comments on the draft report to a Highlands e-mail address.

Key report findings, proposed conservation strategies, and the public listening sessions were announced in numerous local and regional newspapers in New York and New Jersey. These included daily and weekly newspapers: Journal News (Westchester County, NY), Times Herald-Record (Orange County, NY), Daily Record (Morris County, NJ), Star-Ledger (Morris County, NJ), The Record (Bergen County, NJ), and the New Jersey Herald (Sussex County, NJ).

Two public involvement sessions were conducted to receive comments on the draft report. Total attendance was approximately 200 people: 110 in Morristown, NJ, on April 22, 2002, and 90 in Suffern, NY, on April 23, 2002. In addition to the 68 verbal comments recorded at the two sessions, the study team received a total of 94 written comments and more than 3,000 electronic responses (Appendix G). Citizens, residents, landowners, farmers, builders, conservationists, environmentalists, water supply providers, and government and elected officials from Federal, State, county, and local levels responded. Several comments came from groups representing diverse interests such as the New Jersey Farm Bureau, the New Jersey Builders Association, various chapters of the Sierra Club and Audubon Society, and the Appalachian Mountain Club. The comments are summarized in Appendix G.

Additional feedback on the draft report was received verbally through phone calls to the Highlands office, in one-on-one discussions with interested citizens, and in separate group presentations given during the 30-day public comment period in response to requests.

The comments received on the draft study report were used to revise each strategy and to develop associated actions designed to protect the long-term integrity and traditional uses of lands within the Highlands region. For example, as a result of the comments, general hydrology information was added to Section 2, under Water.

About This Report

This updated study report builds on the foundation established by the 1992 study. This update focuses on the location and priority of regional natural resources that are most critical, and on strategies that can be implemented by public and private sectors in the stewardship of the Highlands.

Section 2, Resource Assessment and Conservation Values, briefly describes how data on natural resources were collected and provides key findings for five resource types: water, forest, biodiversity, farmland, and recreation. It shows their distribution and provides a range of their conservation values across the region.

In Section 3, Potential Changes and Resources at Risk, regional demographic information is used as a foundation for build-out and econometric analyses that track potential population growth and development in the Highlands. Those results are interpreted to describe the effects that future growth and development might have on land use, water, and forest resources. This information is used to determine which of the high value resource areas identified in Section 2 are currently not protected, and are at the greatest risk for change. Key findings are emphasized.

Section 4, Resource Summary and Conservation Strategies, briefly reviews the Highlands resources at risk that were determined in Sections 2 and 3. It then describes challenges and opportunities associated with land management and stewardship in the Highlands. In the context of this land management framework, Section 4 offers eight alternative conservation strategies to protect resources in the Highlands.

Section 5, A Fragile Future, provides concluding remarks.

This study report synthesizes and provides findings and some interpretation of the analyses conducted, but does not provide an exhaustive compilation of all possible scenarios for change. Any definitions and assumptions used in the resource assessment and analysis portions of the study are documented in this report. Detailed descriptions of the data sources and methodology, including actual data tables used for the assessment, are available as part of the New York – New Jersey Highlands Technical Report. A list of topics that will be covered in the technical report is provided in Appendix H.

The technical report will be available in hard copy, compact disc (CD), and on the Highlands Web site. The hard copy technical report will primarily contain data, methodology, and definitions for technical terms used in the report. The CD and Web site will contain detailed information such as datasets and metadata and supplemental maps, in addition to what is available in the hard copy report. The data presented in this report are intended for regional analyses and discussion;

however, local-level data will be accessible through an interactive mapping Web site (Arc IMS) being developed by Rutgers University's Center for Remote Sensing and Spatial Analysis as part of the technical report.

SECTION 1 REFERENCES

Michaels, Joseph A.; Neville, L. Robert; Edelman, David; Sullivan, Tim; DiCola, Leslie A. [1992.] New York – New Jersey Highlands Regional Study. [Radnor, PA: USDA Forest Service, Northeastern Area State and Private Forestry]; 130 p.

Van Diver, Bradford B. 1992. Roadside geology of New York. Missoula, MT: Mountain Press Publishing Company; 396 p.

Section 2 Resource Assessment and Conservation Values

Photograph by George M. Aronson

"We abuse the land because we regard it as a commodity belonging to us. When we see land as a commodity to which we belong, we may begin to use it with love and respect."

Aldo Leopold, Conservationist

SECTION 2 RESOURCE ASSESSMENT AND CONSERVATION VALUES

For the resource assessment phase of this study, the study team and work group selected five resource components that provide a comprehensive view of the water and land resources across the Highlands region. These resource components were also chosen to align with the goals for the original 1992 Highlands Regional Study, which were stated in Section 1.

This section describes the status of water, forest, biodiversity, farmland, and recreation resources in the Highlands. It shows their distribution throughout the study area. These resources are then integrated into a Conservation Values Assessment Model to provide a range of conservation values for the resources across the region.

WATER

The water resources of the Highlands have long been recognized as the region's most valuable resource. More than a century ago, before the construction of large-capacity storage reservoirs, water supply reports documented the natural advantages of the region as a collecting ground and as the future source of water supply for rapidly developing urban centers in northeastern New Jersey and New York City (Vermeule 1894, La Forge 1905). These advantages include the Highlands' many natural storage basins, its elevation, and abundant rainfall. The region's elevation allowed the economical delivery of water by gravity flow to dense population centers immediately to the east. The Highlands were noted as an area of good water quality because the area was sparsely settled, largely forested, and poorly adapted for agricultural use. For all of these reasons, these early reports emphasized the need for conservation.

The Highlands ground water and surface water are the direct source of water for more than 4.5 million people in New York and New Jersey. Millions more depend on water that is transferred through Highlands reservoirs from Delaware System reservoirs located in upstate New York and by flow augmentation to streams.

The quality of ground and surface water within the region continues to be among the best nationally, and in some areas stream quality and aquatic communities have improved over the last decade owing to increased environmental regulation and improved wastewater treatment facilities. Although less serious water quality problems occur within Highlands watersheds, the U.S. Environmental Protection Agency (1999) considers the watersheds to be highly vulnerable based on indicators such as urban runoff potential, population change, and hydrologic modification.

Land-use activities are major factors in changing hydrologic and environmental conditions within watersheds. The expected continued growth of population and development in the Highlands would have a significant effect on stream and ground water quality and aquatic communities. Declining ground water levels, changes in the natural flow of streams, habitat degradation, reduction in biological diversity, and a shift toward species more tolerant of disturbance are associated with increasing urban and suburban development. Given the prospect for continued development of the Highlands and increased dependence on Highlands water resources both within the Highlands and in adjacent areas, an increased vigilance in terms of adequate monitoring and assessment of water quantity and quality, and biological resources is warranted in the region.

GROUND WATER—AQUIFERS AND WELLS

Ground water is the primary source of water for residents and businesses in the Highlands region. Aquifer characteristics and the function of the ground water flow system are directly related to the underlying geology, which controls the aquifer's ability to store and transmit significant quantities of water for various uses. Descriptions of aquifer types are provided to aid in understanding the information on ground water use that follows.

AQUIFER TYPES

Five aquifer types within the Highlands study area are classified by the bedrock or surficial materials that are exposed at or near the land's surface. These include crystalline, carbonate, and clastic rocks typical of Highlands geologic formations (Figure 2-1). The study area also includes sedimentary and igneous rocks of the Newark Basin along the eastern boundary that are typical of the Piedmont physiographic province to the east. Locally, all of these bedrock units are overlain by surficial deposits of glacial origin.

BEDROCK AQUIFERS

The crystalline aquifers are composed of crystalline metamorphosed sedimentary and igneous rocks of Pre-Cambrian age and are exposed over 65 percent of the study area. Rock types consist primarily of coarse-grained gneiss, schist, and granite of various mineral compositions. Fine-grained metamorphic slates such

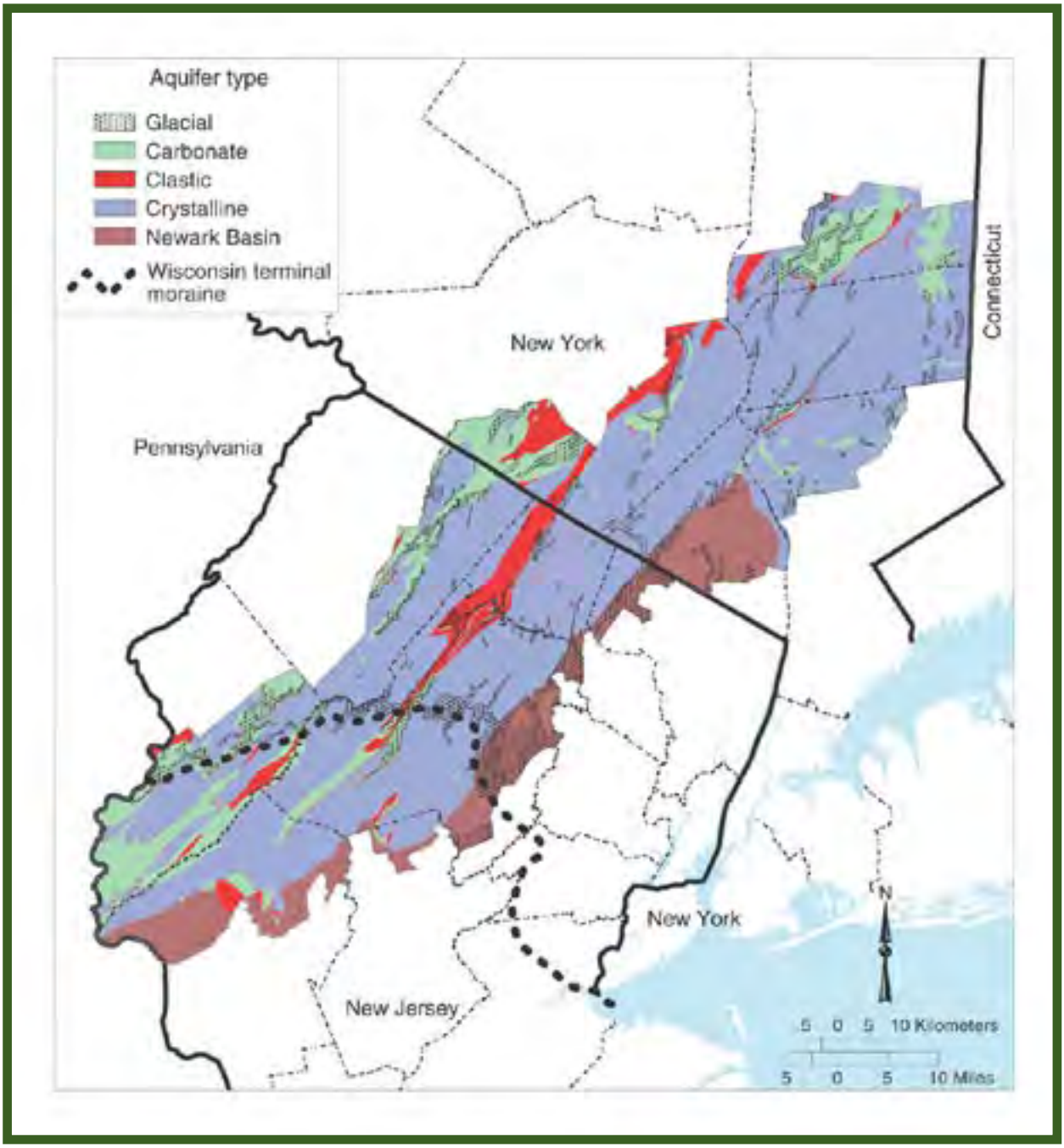


Figure 2-1. Aquifer types. Major aquifer types of the New York – New Jersey Highlands are classified by their bedrock or surficial materials, which affect water infiltration, storage, availability, and chemistry.

as phyllite are common in the New York part of the study area. These rock types are the most resistant to erosion. Therefore, they form the upland regions and generally provide the highest elevations, steepest slopes, and relief typical of Highlands topography.

Carbonate aquifers are composed predominantly of Paleozoic age limestones and dolomites and are exposed over 16 percent of the area. These rock types are less resistant to erosion, are subject to dissolution, and therefore are found on the valley floors interspersed between the more resistant crystalline and clastic rocks that form the valley walls.

Clastic aquifers are composed of Paleozoic age sedimentary sandstone, shale, conglomerates, and quartzite, and comprise 7 percent of the study area. These rock types locally overlie carbonates in some valleys; the more resistant rocks form predominant northeast-southwest trending ridges known locally as Green Pond, Bearfort, Kanouse, and Bellvale Mountains.

Newark Basin aquifers of Mesozoic age are exposed over 12 percent of the area. These rocks are predominantly red sandstones and shales. Conglomerates, particularly near the Ramapo border fault, and basalt and diabase units are also present.

Glacial Aquifers

Glacial aquifers are composed mainly of unconsolidated sand, silt, and gravel of Pleistocene age, and form narrow belt-like deposits of small areal extent. The aquifers comprise channels up to 300 feet thick in some places and can provide significant storage and yields of water.

Aquifer Recharge

Recharge to Highlands bedrock aquifers is predominantly through precipitation that percolates downward through the overlying soil to fractures, joints, or solution openings in the underlying bedrock (Illustration 2-1). The ground water moves from upland recharge areas to discharge areas, such as springs and streams at lower altitudes.

Glacial valley-fill aquifers receive most of their recharge from runoff caused by precipitation that falls on the surrounding bedrock uplands. Some recharge is by infiltration from precipitation that falls directly on the valley-fill aquifers, and some is by inflow from adjacent bedrock aquifers. These sources are sufficient to maintain aquifer water levels above those of streams, so that water moves from the aquifer to the stream (Illustration 2-2A). However, during droughts, discharge by seepage to adjacent bedrock, evapotranspiration, and withdrawals from wells can lower aquifer water levels until flow is reversed and water moves from the stream to the aquifer (Illustration 2-2B).

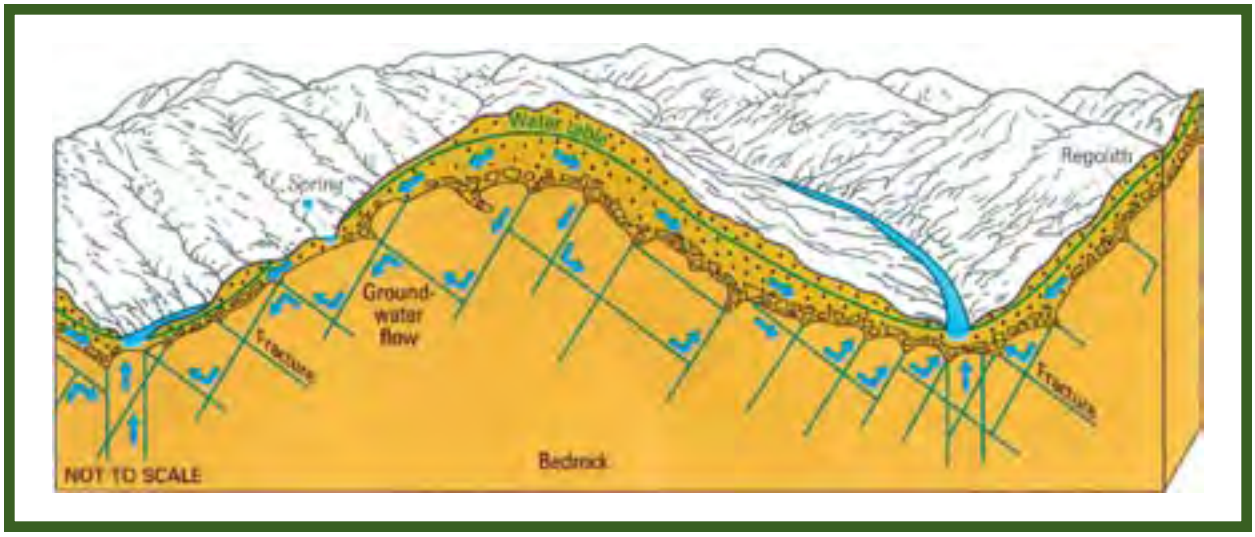


Illustration 2-1. Recharge and flow in bedrock aquifers. Ground water in bedrock aquifers is predominantly precipitation that has infiltrated the overlying soil and the bedrock. At lower elevations the ground water feeds springs and streams (modified from Heath 1980, p. 10).

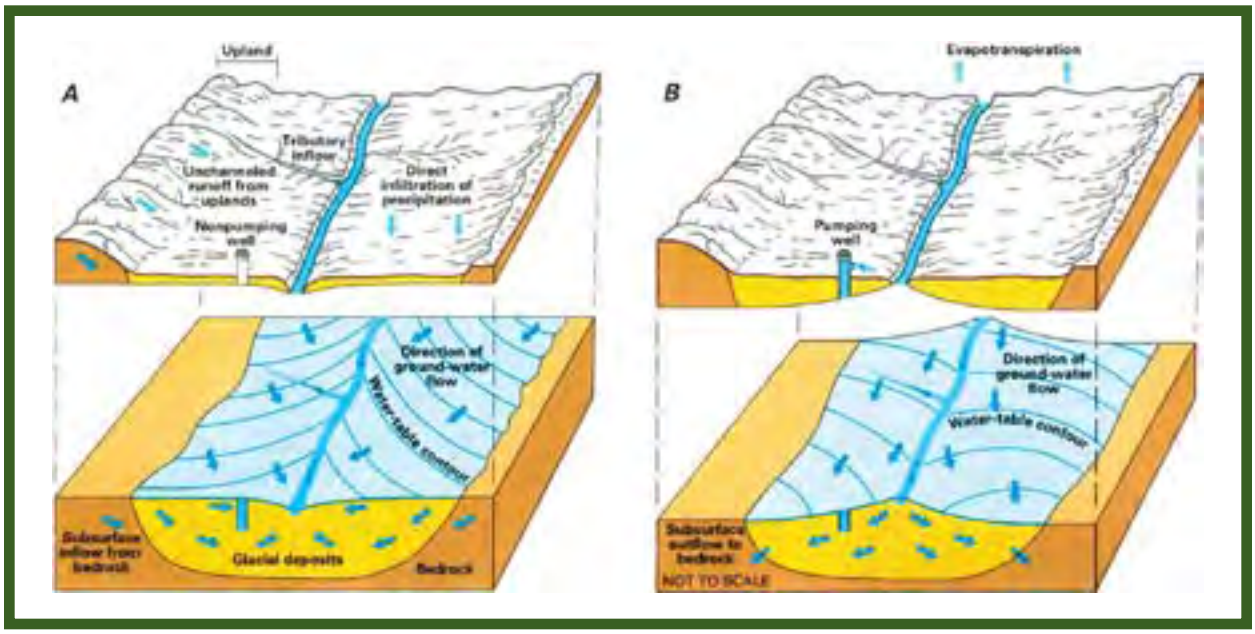


Illustration 2-2. Recharge and flow in glacial aquifers. Ground water enters glacial aquifers in three ways: as runoff from the surface of surrounding bedrock, as underground flow from adjacent bedrock, and by infiltration of precipitation that falls directly over the aquifer. (A) When the water level in a glacial aquifer is above that in streams, ground water flows from aquifer to stream. (B) When the water level in a glacial aquifer drops below that in streams—due to withdrawal from wells, drought, evapotranspiration, and seepage into adjacent bedrock—water flows from stream to aquifer (modified from Rosenshein 1988, p. 168).

Aquifer recharge can be highly variable because it is determined by local precipitation and is influenced by topographic relief and the capacity of the land surface to accept infiltrating water. The degree to which Highlands aquifers have the ability to store and transmit recharge water is based on the amount and connectivity of openings in the underlying rock or sediment. This is also known as the aquifer's permeability and has a direct bearing on the aquifer's ability to yield sufficient quantities of water to wells.

GROUND WATER USE

HIGH-CAPACITY WELLS

Water-use data for 1995 was compiled for more than 1,200 wells for which owners are required to report water withdrawal data to Federal, State, or local agencies. These wells include those used for high-capacity municipal supply, industrial, commercial, irrigation, and mining uses. Figure 2-2 shows the location of wells operating in 1995 and provides information on the volume of withdrawals per well by aquifer type. Areas of note include the large withdrawals from glacial aquifers in central and eastern Morris County and along the eastern boundary of the study area in Passaic and Bergen counties in New Jersey and in Rockland County, New York. Carbonate aquifers provide the majority of ground water in the southwestern part of the study area in eastern Warren and southern Morris counties. These are areas where overlying glacial deposits provide increased ground water storage and yield to the underlying carbonate rocks.

Figure 2-2 also shows the importance of Newark Basin aquifers to Rockland County and crystalline bedrock aquifers in Putnam County, New York. Also notable are the widespread consistency of low yields of crystalline rock aquifers and the paucity of wells drawing water from clastic rock aquifers.

The graph in Figure 2-2 provides a comparison of total ground water withdrawals by aquifer type within the Highlands study area, differentiated by the amount withdrawn by wells in New York and New Jersey. Glacial aquifers are the most productive with almost 60 million gallons per day (Mgal/d) withdrawn. The combined total withdrawal from the four bedrock aquifers is about 56 Mgal/d.

DOMESTIC WELLS

The amount of water supplied by domestic wells across the region was estimated in order to account for this significant source of potable water in rural areas. The number of people in each township in 1995 that depended on water from domestic wells was estimated from the 1990 census data. Each person supplied by a domestic well was assumed to use 85 gallons per day.

Figure 2-3 shows the estimated domestic water use by township. Total domestic withdrawals for 1995 in the Highlands region was estimated to be approximately 30 Mgal/d. Areas with the largest domestic withdrawals in New York are western Dutchess, Putnam, and Westchester counties, and Warwick Township in Orange

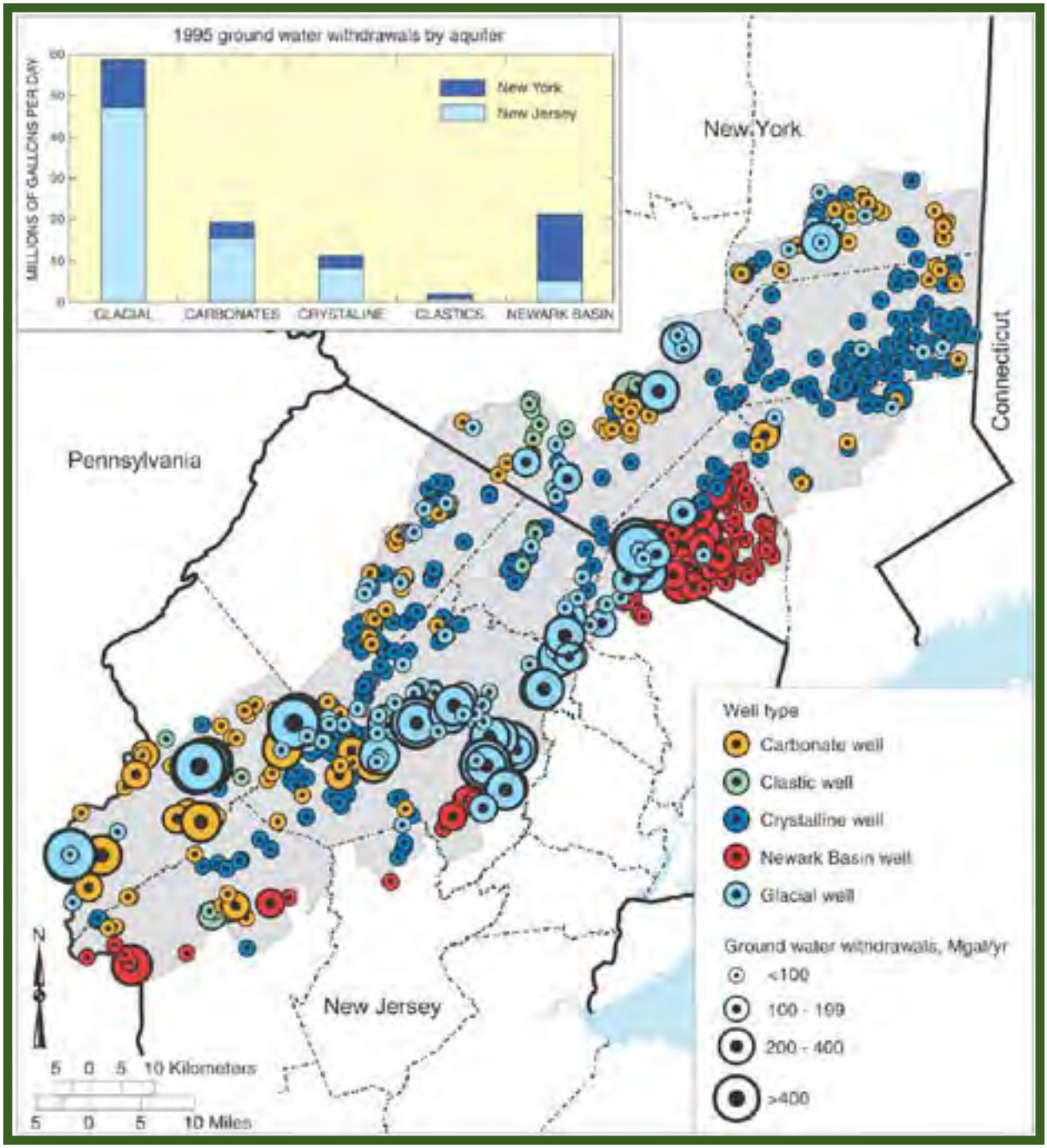


Figure 2-2. Withdrawals from high-capacity wells. The map shows the areal distribution of 1995 withdrawals from major water supply wells in the Highlands. The amount of water withdrawals differs regionally and by aquifer type.

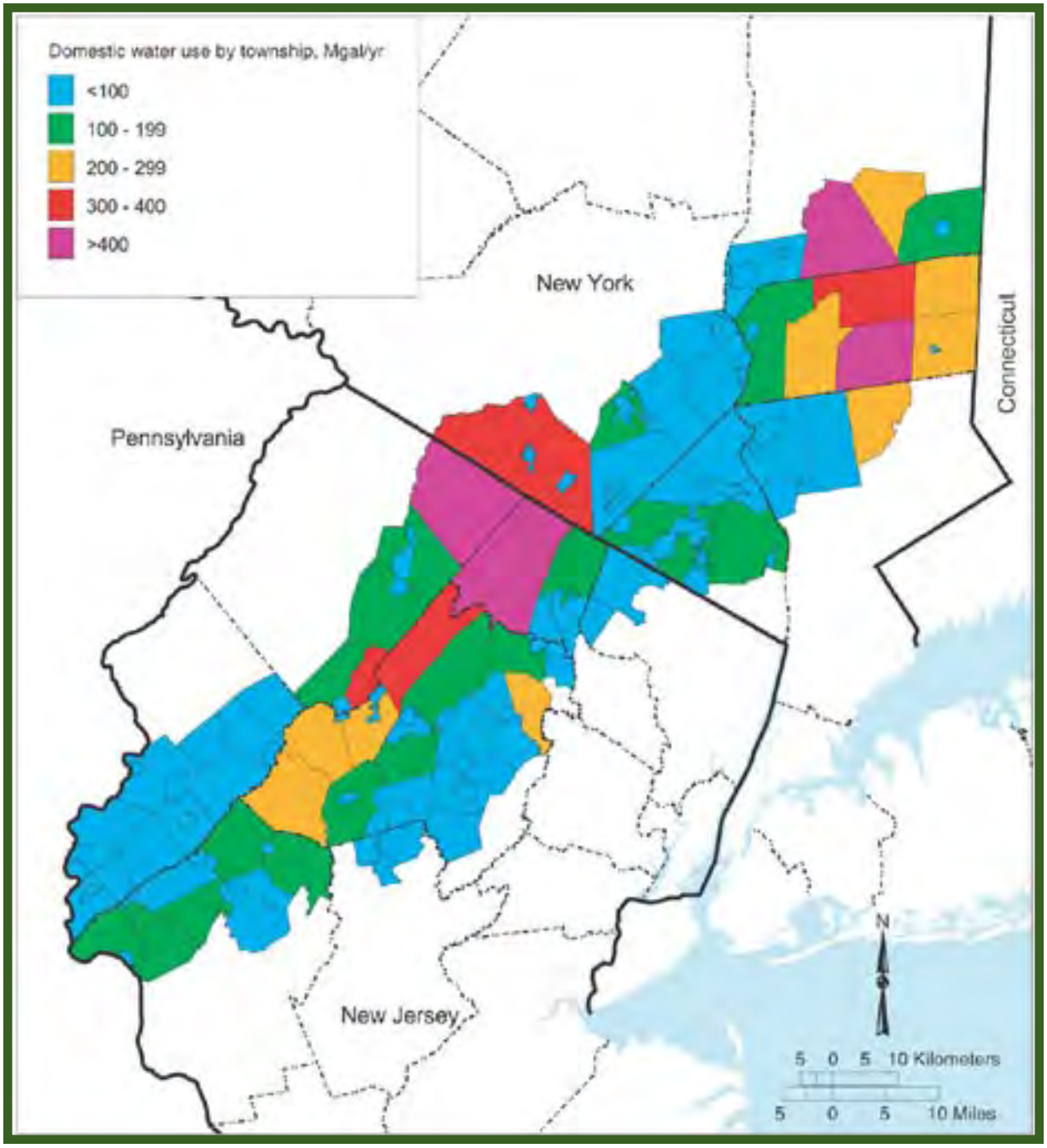


Figure 2-3. Withdrawals from domestic wells by township. Estimated water withdrawals from domestic wells in the Highlands in 1995 were greatest in townships in Dutchess, Putnam, Westchester, and Orange counties in New York; and in Sussex, Passaic, and Morris counties in New Jersey.

County. Areas with the largest domestic withdrawals in New Jersey are Vernon Township in Sussex County, West Milford Township in Passaic County, and Jefferson Township in Morris County.

Monitoring Ground Water Levels

Changes in water levels reflect the general response of the Highlands ground water system to climate changes, changes in recharge patterns, and ground water withdrawals. Water levels typically are highest in winter and early spring as a result of reduced evapotranspiration, low temperatures, snowmelt, and spring rains that recharge the aquifers. Ground water levels typically start to decline as summer begins and continue to decline through late fall. Water use is highest in summer when water is used for irrigation and recreation. More water evaporates from the land surface and transpires from plants also reducing recharge. Water levels are typically lowest in late fall, and they rise again during winter, completing the cycle.

Figure 2-4A shows hydrographs from four selected monitoring wells in Morris County, New Jersey, with 10 years of continuous daily records. These hydrographs show typical fluctuations of ground water levels within the various aquifers of the study area. During periods of prolonged drought, such as from mid-1994 to late 1995 and mid-1998 to mid-1999, water levels fell approximately 5 to 15 feet on average. Shallow wells constructed just below the water table could have problems with water yield or go dry during these prolonged dry periods.

Figure 2-4B shows a water-level hydrograph from a well in East Hanover Township, Morris County, New Jersey. Periodic measurements have been made in this observation well since 1966. This well is used to monitor water levels in the glacial aquifer system within the Whippany River Basin. The declining water levels shown in this well are typical of those from wells located in this part of the Highlands and in wells in municipalities to the east within the basin. The declining water levels are a result of ground water withdrawals from the aquifer exceeding the natural recharge rate of the aquifer.

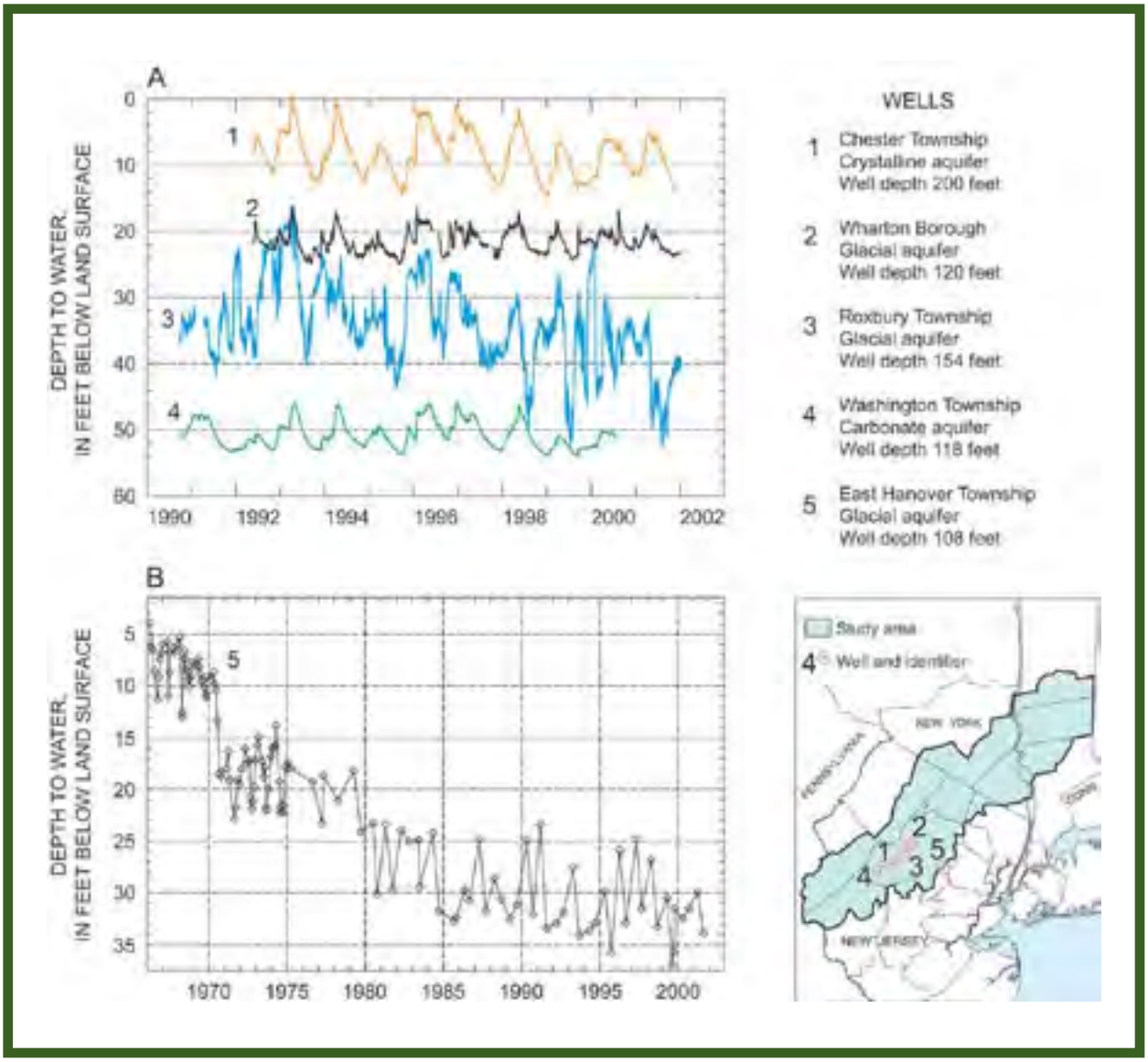


Figure 2-4. Trends in ground water levels. Hydrographs for five wells in Morris County, New Jersey, show (A) typical seasonal fluctuations in ground water levels in wells 1-4, and (B) long-term decline in the ground water level at well 5. Inset map shows the location of each well.

KEY FINDINGS:

- **In 1995, more than 145 million gallons of water per day were withdrawn** from Highlands aquifers.
- **Water use data show that glacial aquifers are the most productive with 60 million gallons per day withdrawn. Crystalline, carbonate, clastic, and Newark Basin aquifers combined produce approximately 56 million gallons per day.**
- **Total domestic withdrawals for 1995** in the Highlands region **are estimated to be approximately 30 million gallons per day.**
- **Long-term monitoring has recorded** water-level **declines of about 5 to 15 feet during drought conditions over the last decade.**
- **Water levels have declined locally as much as 25 to 30 feet since 1965 in the glacial aquifer system within the Whippany River Basin.** Declining water levels within the basin are the result of ground water withdrawals exceeding the natural recharge rate of the aquifer.

SURFACE WATER—STREAMS, RIVERS, AND RESERVOIRS

The Highlands streams and rivers are a significant natural resource to communities both within and outside the Highlands. The rivers and streams within the Highlands are contained within seven major drainage basins: the Housatonic, Fishkill/Hudson, Croton/Hudson, Wallkill/Hudson, Passaic, Upper Delaware, and Raritan (Figure 2-5). The Housatonic River basin has only a small part of the river's upper reaches in the Highlands, and comprises less than 1 percent of the total Highlands area. The Fishkill/Hudson basin contains Fishkill Creek and Moodna Creek, both of which flow into the Hudson River. The Croton River and Peekskill Hollow Creek discharge to the Hudson River in the Croton/Hudson basin, which contains 10 reservoirs. The Wallkill/Hudson basin contains the Wallkill River, which flows northward out of the Highlands, is a Hudson River tributary, and a Highlands boundary. The largest Highlands tributary to the Wallkill River is Pochuck Creek. The Passaic basin has 16 reservoirs and is the largest of the Highlands basins, covering over 29 percent of the Highlands area. The major rivers of the Passaic basin completely or almost completely within the Highlands are the Pompton, Rockaway, Whippany, Pequannock, and Ramapo Rivers. The Hackensack and Passaic Rivers have only short reaches within the Highlands. The Upper Delaware basin has three major Highlands streams that discharge to the Delaware River: the Pequest River, the Musconetcong River, and Pohatcong Creek. The Highlands portion of the Raritan basin contains two reservoirs and parts of the Lamington River, North Branch Raritan River, and South Branch Raritan River.

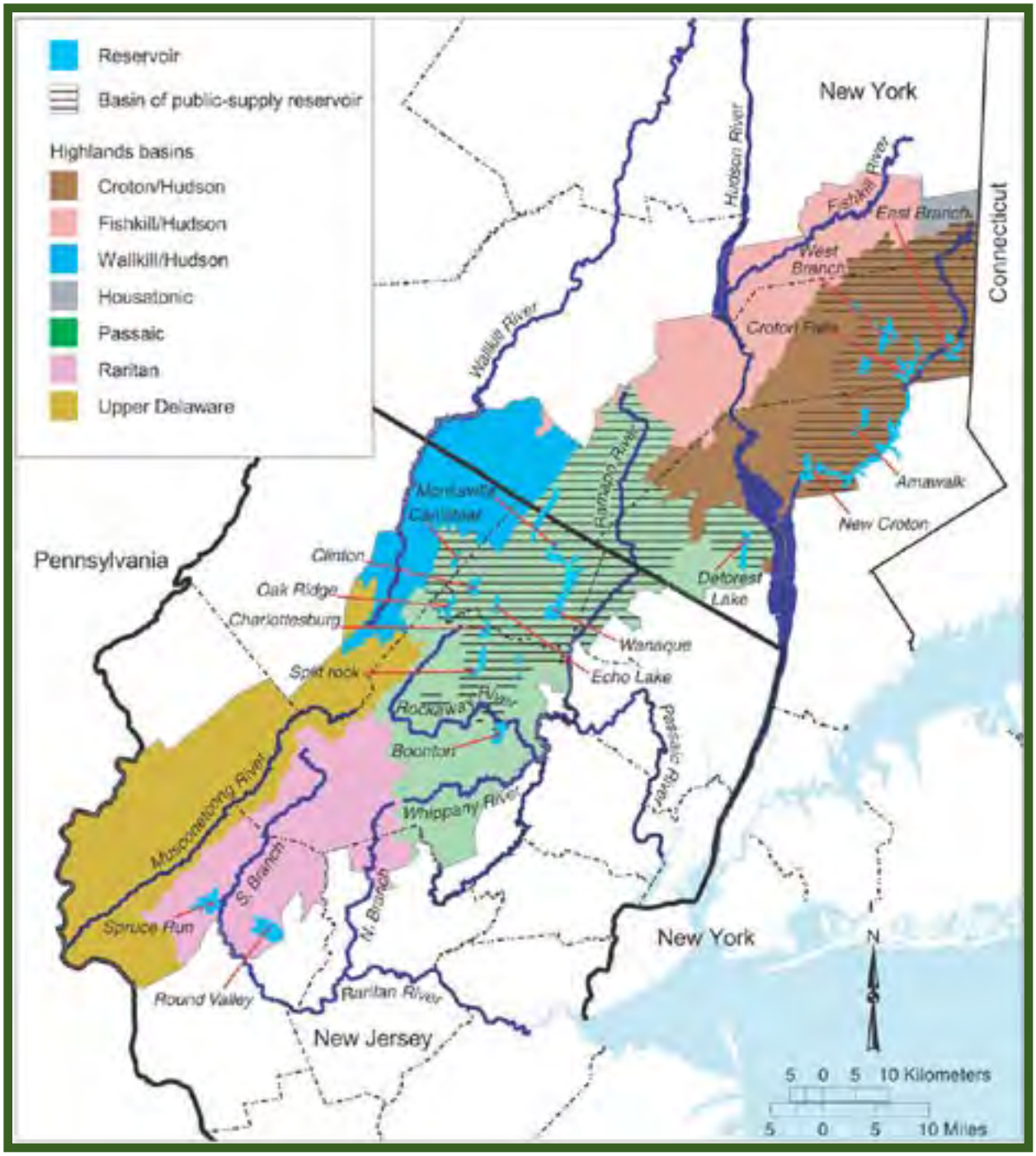


Figure 2-5. Major reservoirs. Seventeen major reservoirs are located within the Highlands study area. Drainage basins are shown for the public-supply reservoirs.

SURFACE WATER USE

The use of Highlands streams and rivers was studied by collecting data on surface-water withdrawals for 1995, the year with the best available Highlands data. There was one exception to the use of 1995 water-use data: the data for the Croton Reservoir system in New York is from 1990 (Linsey and others 1999), because 1995 data could not be obtained. Withdrawals were categorized as irrigation, commercial, industrial, electric utility plant, mining, public supply, or flow augmentation. Highlands surface-water withdrawals for 1995 are estimated at more than 200 billion gallons (Table 2-1). Public-supply withdrawals accounted for 78.3 percent of total withdrawals, followed by flow augmentation (13.4 percent), and industrial (7.7 percent); the other four categories of use represented 0.6 percent of the total.

The Highlands streams, rivers, and reservoirs are an important water-supply source for many communities outside the Highlands (Figure 2-6). Highlands surface-water withdrawals for water-supply use were estimated to be 430.9 million gallons per day (Mgal/d) in 1995. Of this amount, more than 88 percent (379.3 Mgal/d) was transferred to communities outside the Highlands. New York City and 98 New Jersey communities outside the Highlands use Highlands surface water as part of their drinking water supply.

Table 2-1. Use of Highlands surface water, 1995 (Mgal/yr—million gallons per year; Mgal/d—million gallons per day)

Type of use	Withdrawals (Mgal/yr)	Withdrawals (Mgal/d)	Use outside the Highlands (Mgal/d)
Commercial	3.8	0.01	--
Electric utility Plant	761.2	2.09	--
Flow augmentation	26,827.5	73.50	48.2
Industrial	15,395.9	42.18	--
Irrigation	469.8	1.29	--
Mining	15.2	0.04	--
Public supply*	157,276.8	430.90	379.3
Totals	**200,750.2**	**550.01**	**427.5**

*Part of the public supply withdrawals—those from the Croton Reservoir System—are from 1990.

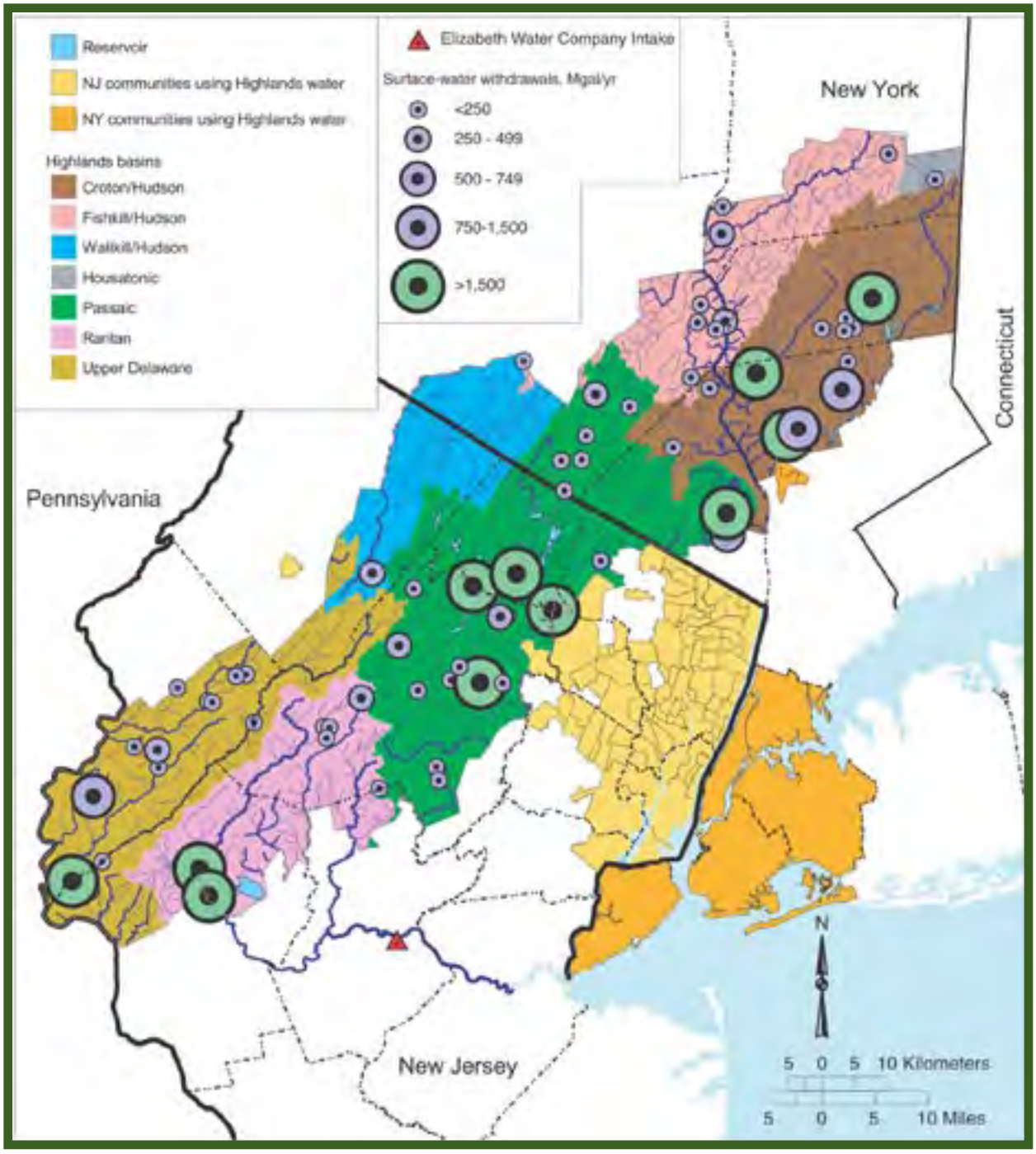


Figure 2-6. Surface water withdrawals. Highlands' streams, rivers, and reservoirs within seven major drainage basins supply communities within and outside the study area, including New York City.

RESERVOIR STORAGE AND TRANSFER

The storage of Highlands surface waters in reservoirs permits the year-round distribution of water for public use. The five major reservoir systems in the Highlands have a combined storage capacity of 323.6 billion gallons (Table 2-2). The 379.3 Mgal/d of Highlands surface water transferred in 1995 to out-of-Highlands communities for public water supply use, originated in either the Wanaque, Newark Water Department, Jersey City Water Department, or the Croton reservoir systems. Figure 2-5 shows the location of the major reservoirs within the Highlands study area.

Water withdrawn from the Croton Reservoir system supplies about 10 percent of New York City's water. Delaware Watershed Reservoir water that passes through the Croton System's West Branch Reservoir provides an additional 50 percent of the City's water supply. The Delaware (River) watershed reservoirs are located northwest of the Highlands, but water from these reservoirs is transferred via an aqueduct into the Highlands West Branch Reservoir—a part of the Croton system—which functions as a settling basin (Figure 2-5). The aqueduct delivers water into the northwestern end of the West Branch Reservoir, and after a residence time, an intake at the southern end of the reservoir returns "settled," less turbid water to the aqueduct on its way to New York City. In 1990, the aqueduct delivered 838 Mgal/d to the West Branch Reservoir (Linsey and others 1999).

Table 2-2. Highlands reservoir systems, storage capacity, yield, and 1995 withdrawals (Mgal/d—million gallons per day)

Reservoir system	State	Type	Storage Capacity* (billion gallons)	Total Safe Yield* (Mgal/d)	Withdrawals 1995 (Mgal/d)
Wanaque	N.J.	Public supply	36	173	149.7
Newark Water Department	N.J.	Public supply	14.4	49.1	40.6
Jersey City Water Department	N.J.	Public supply	115	56.8	43.6
Croton	N.Y.	Public supply	86.6	240	175.4**
Raritan Basin	N.J.	Public supply and flow augmentation	66	160	48.2
United Water New York	N.Y.	Public supply	5.6	Unknown	6.3
Totals	--	--	**323.6**	**678.9**	**463.8**

*New Jersey reservoir data for storage capacity and total safe yield are from New Jersey Department of Environmental Protection and Energy (1992). The New York storage capacity data are from New York City Department of Environmental Protection (2002). New York total safe yield data are from Zimmerman (2001).

**Croton Reservoir System withdrawal data are for 1990 and are taken from Linsey and others (1999).

The Raritan Basin reservoirs are used for public water supply and flow augmentation. Flow augmentation is the transfer of water from a reservoir to a stream or river to meet a required minimum passing flow at a specified location or locations on that stream or river. The New Jersey State Water Supply Act of 1958 set minimum passing-flow requirements at three U.S. Geological Survey gauging stations outside the Highlands, but downstream of the Raritan Basin reservoirs: the South Branch Raritan River at Stanton (40 Mgal/d), the Raritan River at Manville (70 Mgal/d), and the Raritan River at Bound Brook (90 Mgal/d). These minimum passing flow requirements were established to ensure adequate flow in the Raritan River to support aquatic life, assure flow to downstream water users, and provide adequate flow to dilute pollution (New Jersey Water Supply Authority 2000).

Flow augmentation of the Raritan River by releases from the Raritan Basin are necessary because of the large quantity of water withdrawn by Elizabethtown Water Company from the Raritan River for public supply use. Elizabethtown Water Company withdrew 117 Mgal/d in 1995 from its intake on the Raritan River (Figure 2-6). The intake is downstream of the Stanton and Manville gauging stations, and upstream of the Bound Brook gauging station. Without flow augmentation, there would be times when Elizabethtown Water Company could not withdraw the amount needed for its public supply needs and still have the required minimum passing flows on the South Branch Raritan River and Raritan River.

A total distance of about 28 miles of the Raritan River has its flow augmented with water from the Raritan Basin reservoirs Spruce Run and Round Valley. Spruce Run Reservoir is filled naturally by Spruce Run Creek. Round Valley Reservoir was excavated on a hilltop above the South Branch Raritan River, has a small natural basin, and is filled mainly by water pumped up to it from the South Branch Raritan River (New Jersey Water Supply Authority 2000). Round Valley Reservoir has the largest storage capacity (55 billion gallons) of any New Jersey Highlands reservoir. Spruce Run and Round Valley reservoirs released an average of 48.2 Mgal/d in 1995 to meet the minimum required passing flows, and the released water was also a part of the 117 Mgal/d withdrawn from the Raritan River by Elizabethtown Water Company in 1995. The large natural drainage basin of Elizabethtown Water Company's intake and passing flow requirements prevent the quantification of the water released from the Raritan Basin reservoirs that is actually withdrawn for public water supply.

The Highlands reservoirs are especially important because of their ability to store water for use at critical times, such as during a prolonged drought. The ability of reservoirs to have sufficient storage capacity for such critical times is expressed as a reservoir's "safe yield." Safe yield is defined as the yield from a reservoir that can be continuously maintained throughout a repetition of the most severe drought of record, after compliance with required passing flows, and assuming no

significant changes in upstream patterns of water use (modified from New Jersey Department of Environmental Protection and Energy 1992, p. C-3).

Table 2-2 lists the documented storage capacities and safe yields for the Highlands reservoir systems. The safe yields are greater than the 1995 withdrawals, which indicates these reservoirs could meet public-supply demands even during the drought of record. This assumes the reservoir withdrawals for 1995 are representative of current mean annual withdrawals, and this also assumes that withdrawals during a drought equal to the drought of record would not increase significantly from the mean annual withdrawals. This assumption is reasonable since water-use restrictions during a drought emergency should decrease withdrawals. Reservoir withdrawals in 1995 from the Jersey City, Newark, and Wanaque systems ranged between 77 and 86 percent of published safe yield estimates. Reservoir withdrawals in 1990 from the Croton system were 73 percent of published safe yield estimates.

KEY FINDINGS:

- **Surface-water withdrawals from Highlands reservoirs and streams were approximately 550 Mgal/d in 1995.** Public-supply withdrawals account for about 78 percent of the total withdrawals or 431 Mgal/d. Industrial use and streamflow augmentation comprise much of the remaining 22 percent.
- **Highlands surface water reservoirs are the major water-supply source for numerous communities outside the Highlands.** Approximately **88 percent (379 Mgal/d) of the 431 million gallons per day of surface water withdrawn for public supply use is transferred out of the Highlands** region to supply parts of New York City and 98 New Jersey municipalities.
- In addition to water that originates in the Highlands, **more than 838 million gallons per day is transferred from Delaware System reservoirs via aqueduct through the West Branch Reservoir within the Highlands on its way to the New York City area.** This water accounts for approximately 50 percent of New York City's water supply.
- **The major reservoir systems in the Highlands** including the Croton, Wanaque, Newark, Jersey City, and Raritan Basin **have a combined storage capacity of 324 billion gallons and a combined safe yield of about 679 million gallons per day. Total water withdrawals from these reservoirs was about 464 Mgal/d in 1995.**
- **Highlands reservoirs are especially important because of their ability to store water for use during critical times, such as prolonged drought.** Withdrawals from the Jersey City, Newark, and Wanaque reservoir systems in 1995 ranged between 77 and 86 percent of published safe yield estimates. Withdrawals from the Croton system in 1990 were 73 percent of published safe yield estimates.

WATER QUALITY

GROUND WATER

Although the ground water within the Highlands is generally of good quality for most uses, in local areas individual constituents may exceed accepted standards as established by the U.S. Environmental Protection Agency Secondary Drinking Water Regulations that primarily regulate aesthetic quality. Based on analytical results from more than 300 wells within the study area, 16 percent of all wells sampled exceeded the limit of 50 parts per billion (ppb) for manganese. Samples from 12 wells exceeded the limit of 300 ppb for dissolved iron. Manganese and iron usually occur together especially where dissolved oxygen is low. Median values of dissolved oxygen were lowest in the clastic and glacial aquifers; consequently, values of dissolved iron and manganese were usually highest. Dissolved arsenic was detected in several samples; only 1 of 205 samples exceeded the proposed U.S. Environmental Protection Agency maximum contaminant level of 10 ppb for arsenic. Occasional detectable levels of dissolved lead were also observed. Other constituents that occasionally did not meet the standards include dissolved sodium, dissolved chloride, and total dissolved solids. Dissolved solids are generally highest in samples from the glacial and carbonate aquifers, while dissolved chloride values were typically highest in samples from the glacial aquifers.

Most ground water samples had pH values within the acceptable range of 6.5 to 8.5 units, with values typically highest in the carbonate and glacial aquifers.

Elevated concentrations of naturally occurring radon-222 are common in Highlands ground water, particularly from crystalline aquifers, where uranium deposits are common in the rocks. A comprehensive examination of New Jersey radon data by dePaul and others (2000) found that more than 90 percent of 565 samples from within the Highlands exceeded the proposed maximum contaminant level of 300 picocuries per liter.

Dissolved nitrate analyses were available for 307 sites. Dissolved nitrate was present in detectable amounts in 80 percent of all samples; however, only one sample exceeded the maximum contaminant level of 10 parts per million (ppm). Nitrate was detected most frequently and in highest concentrations from water in wells open to the carbonate and glacial aquifers, with median values of 1.3 milligrams per liter (mg/L) in carbonate aquifers and 0.9 mg/L in glacial aquifers. This is consistent with the rapid transport of water from the land surface down to well intakes in these aquifers.

Volatile organic compounds as well as some pesticides were also detected in ground water samples. Data from known regulated sites were excluded. The most commonly detected volatile organic compounds in ground water samples were chloroform, methyl tert-butyl ether (MTBE), trichloroethene (TCE),

tetrachloroethene (PCE), and 1,1,1-trichloroethane (TCA). MTBE is a fuel additive, and TCE, PCE and TCA are chlorinated solvents used extensively in commercial and industrial applications. Most detections were at or below 1 ppb; however, three samples did not meet drinking water criteria. Pesticides were detected in ground water samples, although less frequently and in lower concentrations than in surface water. Most occurrences were in trace amounts, and drinking water criteria were not exceeded. Deethylatrazine, a degradation product of atrazine, was most frequently detected. Identified contaminants are of particular concern to domestic well owners because current regulations do not address the routine sampling of these types of wells.

Although these data were not evaluated with respect to land use within the recharge area at each well, the premise that human activities can affect the quality of ground water has been tested and validated in numerous studies. Elevated ground water nitrate concentrations have been attributed to application of nitrogen-bearing fertilizers and septic-system effluent. In a detailed study of the effects of land use on water quality in the Croton Watershed, elevated nitrate levels were related to density of unsewered housing (Heisig 2000). Elevated chloride concentrations have been attributed to road deicing but may also occur from septic-system effluent. Pesticide occurrence in ground water is more frequent in agricultural or urban areas than in areas that are undeveloped. Volatile organic compounds have been associated with urban and industrial development.

Surface Water

In order to assess changing conditions in Highlands surface water quality over time, trends analyses were conducted at 23 sites within the region for selected constituents from 1986 to 1995 (Hickman and Barringer 1999). Most Highlands streams showed decreases (improving conditions) in total ammonia, phosphorus, and nitrogen, attributable to sewage treatment plant upgrades; however, nitrates are increasing at several sites. Highlands waters are generally well oxygenated and have appropriate temperatures to sustain aquatic life. Results of trends' tests indicate relatively stable conditions with respect to temperature and stable to improving conditions for dissolved oxygen. Bacterial (fecal coliform) levels were also found to be stable. Total dissolved solids, sodium, and chloride, however, were found to increase at most sites.

To assess current conditions, water quality data were examined from a network of stations within the Highlands that were routinely sampled from 1995 to 2001. As a basis of comparison, median values of selected constituents were examined with respect to New Jersey surface water criteria (New Jersey Department of Environmental Protection 1998) and median values of all established surface water status sites for the same period. These status sites are a randomly selected population of New Jersey streams from each of the 20 Watershed Management Areas. These streams represent a current condition of waterways Statewide and

can serve as a point of comparison for the water quality of Highlands streams. Most streams within the Highlands are typically higher in dissolved oxygen and pH than those at status sites (higher quality) but also contain higher median concentrations of total nitrogen, dissolved nitrate, total phosphorus, as well as total dissolved solids, sodium, and chloride (lower quality).

Nitrogen and phosphorus are essential elements for plant and animal growth; however, elevated concentrations in streams can promote excessive growth of algae and other nuisance plants. Although concentrations of dissolved nitrate do not exceed surface water quality standards, concentrations are elevated with respect to status sites and are increasing in several Highlands waterways. Although total phosphorus concentrations are decreasing in many of the Highlands streams, elevated levels of this nutrient are still a concern. Fifteen percent of all samples exceed the phosphorus criterion of 0.1 ppm, and more than half of the samples were observed at two stations.

The fecal coliform count is an indicator of the sanitary quality of water. Fecal coliform contamination can originate from point and nonpoint sources. The primary point source is sewage treatment plant outfalls; nonpoint sources include runoff from manure-treated fields, septic system failure, sewer overflow, and wildlife waste. Fecal coliforms do not necessarily cause illness, but high levels may indicate the presence of other pathogens that can cause waterborne diseases. Although they have stabilized, levels of fecal coliform bacteria remain somewhat elevated in streams within the Highlands. In fact, fecal coliform count was the measure that most frequently did not meet instream standards. Forty-one percent of all samples at the evaluated sites exceeded the reference level of 400 coliforms per 100 milliliters of water. This criterion is based on a 10 percent exceedance rate for samples taken during a 30-day period; exceedances here are attributed to all samples taken from 1995 to 2001. Most individual sites examined had more than 10 percent of samples above this reference level, with several sites at more than 70 percent. Fecal coliform counts were generally higher than those at status sites.

Pesticides (herbicides and insecticides) were detected more frequently and in higher concentrations in Highlands surface water than in ground water, but rarely did levels approach drinking water standards or health advisories. All detections were less than 1 ppb. The most commonly detected pesticides in study area surface waters were herbicides such as atrazine and prometon and an insecticide, diazinon. The most frequently detected volatile organic compounds in streams and ground water are compounds used in gasoline or for commercial and industrial purposes. Volatile organic compounds were detected in surface waters, but less frequently and in lower concentrations than in ground water. Methyl tert-butyl ether (MTBE), a gasoline additive, was the most frequently detected in nearly 50 percent of 42 samples at 28 sites. Occasional detections of chlorinated solvents in surface water were also observed, but in low concentrations.

Many of the routinely sampled sites in the Highlands are located within large watersheds of mixed land uses and therefore reflect the cumulative effects of those various land uses as well as point discharges into the streams. Studies that are designed to examine the effects of land use on stream water quality, such as the U.S. Geological Survey's National Water Quality assessment (NAWQA) Program, have found that nutrient concentrations in surface water are related to urban and agricultural activities. Concentrations in streams that drain urban and agricultural watersheds tend to be significantly higher than those that drain predominantly forested watersheds. Pesticide occurrence was related to both agricultural and urban settings. In general, volatile organic compound occurrence in streams is directly correlated to the percent of urban land use within a watershed, increasing as an area becomes more urban.

BIOLOGICAL INDICATORS

Aquatic communities such as benthic macroinvertebrates and algae are used as biological indicators of stream health because their condition enables the discrimination of human influences on the environment in a predictable way. These communities respond to changes in stream quality from a variety of factors that modify habitat or other environmental features such as land-use, water chemistry, and streamflow.

The primary factors related to degradation of benthic communities are the percentage of urban land use within the associated drainage basin as well as the amount of upstream wastewater discharges (Kennen 1999). Hydrologic factors such as reduced baseflow and increased peak discharges commonly associated with urbanization can substantially alter stream habitat by scouring the streambed, increasing siltation, and transporting contaminants. Conversely, the total amount of forested land within a drainage basin is the best predictor of an unimpaired community.

The New Jersey Department of Environmental Protection's Ambient Biomonitoring Network (AMNET) is a Statewide network of sampling sites designed to monitor the condition of benthic macroinvertebrate communities in New Jersey streams. The network incorporates more than 800 sites, of which 138 are within the Highlands study area. The initial round of sampling was conducted from 1992 through 1996 with a second round to be completed in 2002. The New York Department of Environmental Conservation (Bode and others 1993) operated a similar network from 1986 to 1992, although data within the Highlands area are limited.

Macroinvertebrate community sampling sites shown in Figure 2-7 are classified as nonimpaired, moderately impaired, and severely impaired. (New Jersey data depicted are from the second round of sampling.) Impairment may be indicated by the absence of sensitive species, such as mayflies, stoneflies, and caddis flies;

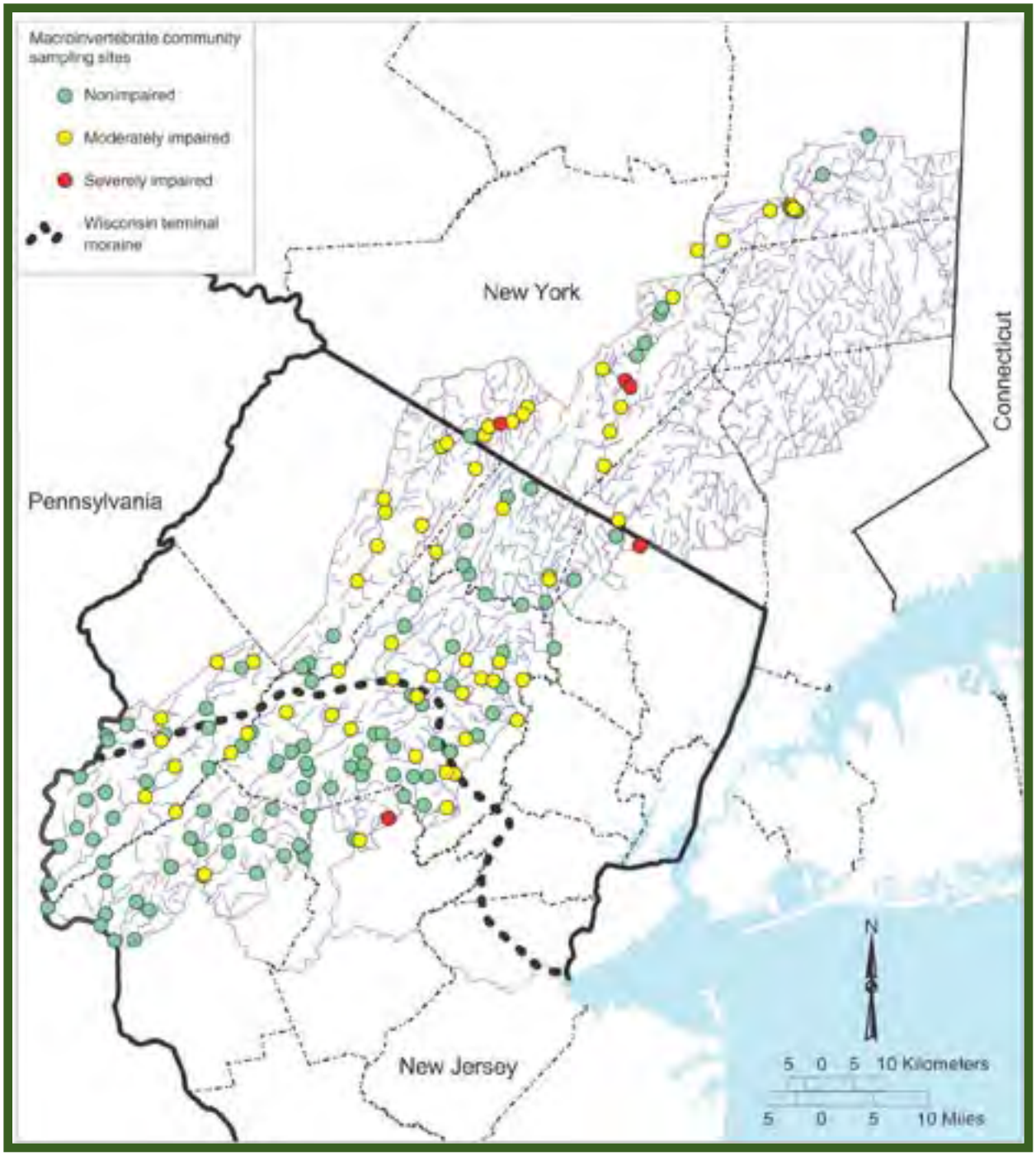


Figure 2-7. Condition of macroinvertebrate communities in streams. Sampling of macroinvertebrate communities—predominantly aquatic insects—in surface water shows comparatively healthy populations and good water quality. Nonimpaired sites (highest quality) have diverse, well-balanced communities; moderately impaired sites have less diverse communities, and severely impaired sites are dominated by a few tolerant species. (New Jersey data was collected from 1997 to 1999; New York data from 1986 to 1992. Adapted from New Jersey Department of Environmental Protection, Bureau of Freshwater Biological Monitoring 2001, and Bode and others 1993).

by the dominance of more tolerant species such as aquatic worms and midges; or by an overall reduction in community diversity. Nonimpaired sites have diverse, well-balanced macroinvertebrate communities comparable to those of other undisturbed streams with similar characteristics. Moderately impaired sites show alterations of the community from a pristine state, with a reduction in species diversity and in the number of sensitive species present. Severely impaired sites are dominated by a few tolerant invertebrate species.

Data from the first round of sampling indicated comparatively healthy aquatic invertebrate populations within Highlands waters (Kennen 1999). Streams within the Upper Delaware drainage basin as well as those south of the Wisconsin terminal moraine were least likely to exhibit an impaired macroinvertebrate community. Of the sites within the study area, 38 percent exhibited some degree of impairment (5 percent severely impaired) and 62 percent showed no impairment. Of non-Highlands sites, 70 percent indicated some degree of impairment (14 percent severely impaired) while only 30 percent were considered nonimpaired.

The second round of sampling showed that 3 percent of the sites within the study area exhibited impairment (1 percent severe impairment) while 67 percent were nonimpaired, indicating stable to slightly improving conditions. Of the non-Highlands sites that have been sampled, 67 percent retain some degree of impairment. Some of the major waterways having impaired communities at more than one sampling site include the Whippany River, the Rockaway River, the Wallkill River, the Musconetcong River, the upper reaches of the Pequannock River, and the Pohatcong Creek. Within New York, waters identified as having impaired communities include the Ramapo River and Wawayanda Creek.

The U.S. Geological Survey's National Water Quality Assessment (NAWQA) Program compared the aquatic community status of 36 northern New Jersey stream sites to 140 selected NAWQA sites nationwide. Invertebrate and algal status are related to an urban land use gradient (Figure 2-8). Generally, highest scores (most degraded sites) occur where percentage of urban land use is greatest within a basin. The Rockaway River at Boonton, Lamington River near Pottersville, South Branch Raritan River at Arch Street, Spruce Run at Glen Gardner, and Pequannock River at Riverdale had some of the lowest scores (least degraded sites) nationally for algae and invertebrates (Ayers and others 2000). Land use in the basins of these sites is less than 34 percent urban and greater than 41 percent forested.

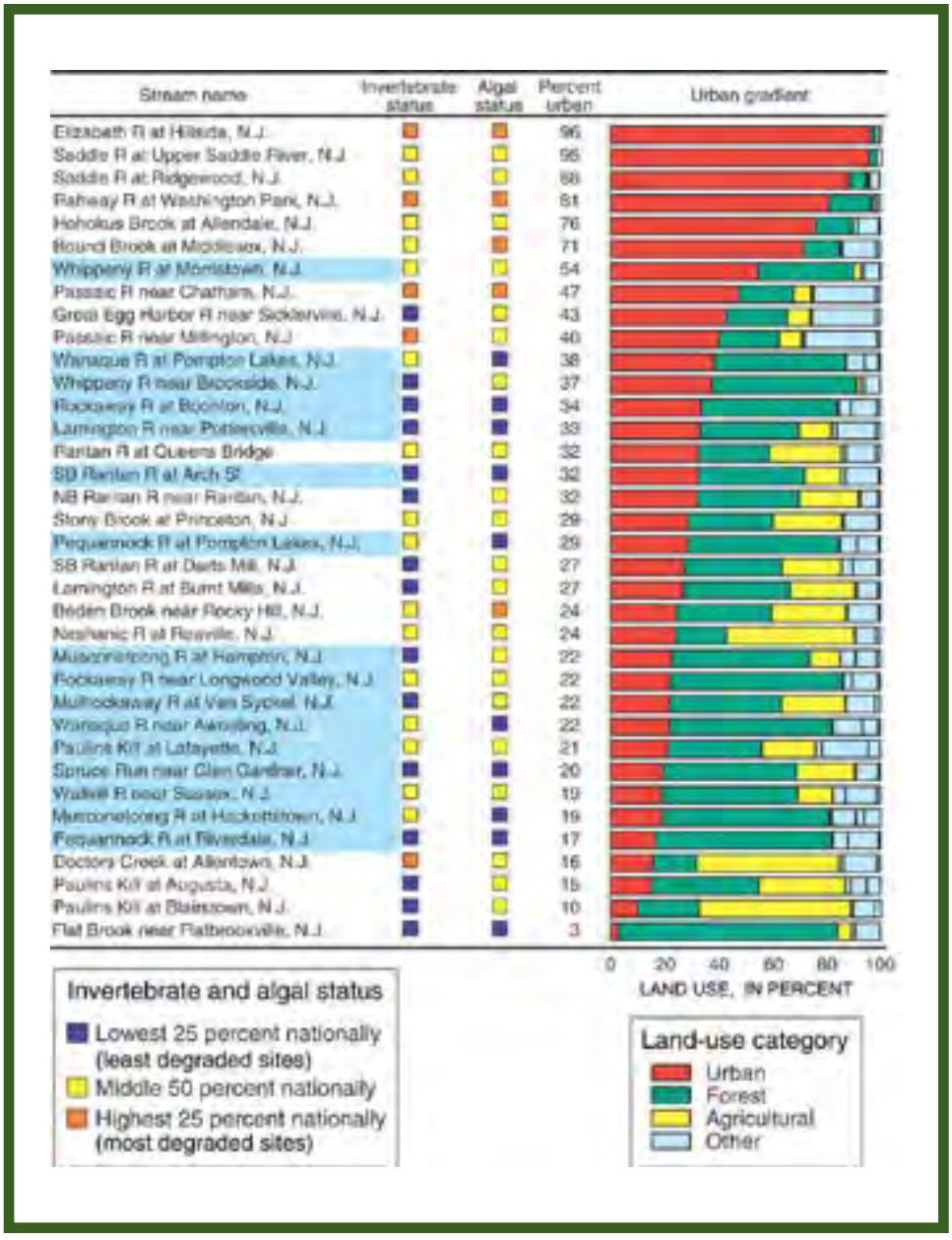


Figure 2-8. Land use and biological status of streams. The invertebrate and algal status of New Jersey Highlands stream sites (shaded in blue) and other northern New Jersey stream sites show that stream health is greatest where urban land-use is lowest (modified from Ayers and others 2000, p. 10).

WATER: WATER QUALITY

KEY FINDINGS:

- **The natural ground water within the Highlands is of good quality for most uses.** Exceedances of U.S. Environmental Protection Agency's Secondary Drinking Water Regulations, which primarily regulate aesthetic quality, may be encountered locally and include manganese, iron, sodium, chloride, and dissolved solids.
- **Elevated concentrations of naturally occurring radon-222 are common in Highlands ground water, particularly from crystalline aquifers.** More than 90 percent of 565 ground water samples from within the Highlands exceed the proposed maximum contaminant level of 300 picocuries per liter.
- **Elevated ground water nitrate concentrations have been attributed to application of nitrogen bearing fertilizers, septic-system effluent, and unsewered housing density. Elevated chloride concentrations** in ground water have been **attributed to road de-icing** but may also occur from septic-system effluent. **Pesticide occurrence** in ground water is **more frequent in agricultural and urban areas** than in areas that are undeveloped. **Volatile organic compounds** have been **associated with urban and industrial development.**
- **Over the past decade, many Highlands streams show improving conditions.** Decreases in total ammonia, phosphorus, and nitrogen are attributable to sewage treatment plant upgrades. Fecal coliform levels are generally stable, however elevated levels remain a concern. Dissolved solids, sodium, and chloride were found to increase at most sites, possibly due to road deicing or upstream point discharges.
- **Pesticides (herbicides and insecticides) were detected more frequently and in higher concentrations in Highlands surface water than in ground water; but levels rarely approached limits for drinking water standards or health advisories.**
- **The most frequently detected volatile organic compound in Highlands streams was** methyl *tert*-butyl ether **(MTBE), a gasoline additive.**
- **Sampling of macroinvertebrate communities in Highlands streams indicate comparatively healthy aquatic invertebrate populations.** In the most current sampling, 67 percent of Highlands macroinvertebrate sites was nonimpaired, 33 percent exhibited some degree of impairment, and 1 percent was severely impaired.

WATER BUDGET

A water budget is a valuable tool in understanding how human activities can alter the natural cycle and availability of water in the Highlands. The water budget considers all water, both surface and ground, entering, leaving, or stored within a watershed. Each component of the hydrologic cycle (Illustration 2-3)—precipitation, infiltration, overland runoff, evapotranspiration, and ground and surface water withdrawals—can be assigned a value in order to create a water budget.

ANALYSIS AT A REGIONAL SCALE

A water budget for the entire New York – New Jersey Highlands region provides a basis for understanding the function and magnitude of the various components (Figure 2-9). The primary source of water is precipitation, which totals about 50 inches annually when averaged over the entire study area. This is the equivalent of receiving 5,300 Mgal/d of water over the 2,218 square miles of the study area. Of the total precipitation, an estimated 2,153 Mgal/d evaporates from land or water surfaces and transpires from vegetation; these processes together are referred to as evapotranspiration. The remainder of the precipitation either infiltrates into the ground (1,958 Mgal/d) and recharges ground water or runs off the land surface (707 Mgal/d) to streams and rivers during storms and snowmelt. The ground water in turn discharges to streams, which is known as stream baseflow, and generally equals the amount of water infiltration or recharge into the ground (1,958 Mgal/day). Stream baseflow is responsible for maintaining flow in streams even during prolonged dry periods. Therefore, natural streamflow out of the Highlands region is a combination of baseflow (1,958 Mgal/d) and runoff (707 Mgal/d) and totals 2,665 Mgal/d.

Human activities can add to or subtract from evapotranspiration, infiltration, baseflow, and runoff. Consumptive use of surface and ground water amounts to an estimated 482 Mgal/d removed from the overall Highlands water budget. This amount is based on the 427 Mgal/d transferred out of the region from Highlands reservoirs to supply major urban areas to the south and east in New York City and New Jersey, plus 20 percent of the region's ground water use (29 Mgal/d), and 20 percent of surface-water withdrawals (26 Mgal/d) for use within the Highlands.

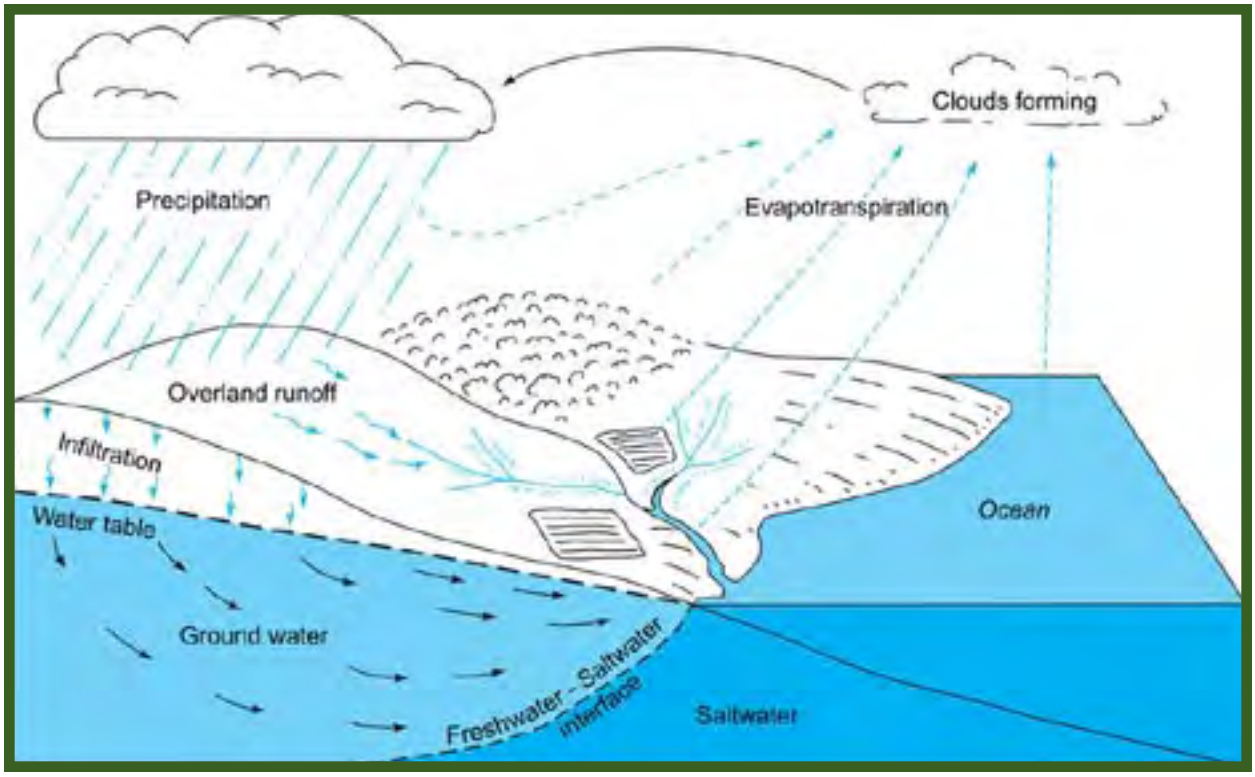


Illustration 2-3. Hydrologic cycle. The constant movement of water above, on, and below the Earth's surface constitutes the hydrologic cycle. Precipitation runs over the land surface and into streams, which discharge into the ocean. Some precipitation infiltrates into the ground-water system and discharges to streams or the ocean. Transpiration and evaporation return water to the atmosphere, completing the cycle (modified from Heath 1983, p. 5).

Figure 2-9. Highlands regional water budget. The water budget considers all water, both surface and ground, that enters and leaves the Highlands. On an average annual basis, the Highlands receives about 50 inches of precipitation which is the equivalent of 5,300 million gallons per day (Mgal/d) over the study area. About 50 percent (2,665 Mgal/d) of this water leaves via streamflow. An estimated 41 percent (2,153 Mgal/d) is lost to evapotranspiration, and about 9 percent (482 Mgal/d) is consumptive water use that is not returned to Highlands watersheds.

Analysis at a Watershed Scale

The amount of precipitation that falls on Highlands watersheds varies geographically based mainly on topography, and generally averages 44 to 52 inches per year. The areas of highest elevation generally receive the most precipitation. On a year-to-year basis over the past century, annual precipitation has varied from these averages locally as much as 10 to 20 inches. An example of how the major water budget components are influenced by annual fluctuations of precipitation in the Highlands region is shown graphically in Figure 2-10. Annual mean streamflow for a period of 80 years, recorded at a gauging station on the Pequest River at Pequest in Warren County, New Jersey, is compared with local annual precipitation for the period. Approximately half of the precipitation that falls on the watershed leaves the watershed as stream discharge. Most of the remainder that does not discharge as streamflow leaves the basin as evapotranspiration. A similar relationship exists over most of the Highlands region.

The annual variability in precipitation a watershed receives can significantly affect annual totals of stream discharge, particularly during very dry and very wet periods. These variations in turn affect the quantity and quality of water available to downstream users. Total annual stream discharge averages about 20 inches per year at the Pequest gauge. During the drought of record (1961-1966) total annual stream discharge averaged 40 to 70 percent less than long-term averages. During unusually wet years, such as 1952, 1975, and 1996, total annual stream discharge was 70 to 90 percent greater than long-term averages. Other stream gauging stations in the Highlands indicate similar ranges of departure from average streamflow conditions during extremely dry and wet periods including the Whippany River at Morristown, Ramapo River at Mahwah, and the South Branch Raritan River near High Bridge (Bauersfeld and Schopp 1991).

Floods and droughts can affect the quality of surface water. During floods, large quantities of pollutants are washed into streams, but because of the large volume and velocity of the water, the pollutants are diluted and move quickly downstream. During droughts, however, streamflows may not be sufficient to dilute effluents from industries and sewage treatment plants, and contaminants that may be in the ground water that is discharging to streams.

Changing streamflow characteristics are strong indicators of changing watershed conditions. Of particular importance in water budget analyses are the two components of streamflow, which are baseflow and runoff. At the Pequest stream gauge, baseflow makes up about 83 percent of total stream discharge and runoff makes up the remaining 17 percent (Figure 2-10). There is only a slight variation in the percentage of these two components over the period of record. However, baseflow and runoff characteristics of streams vary from watershed to watershed and are important indicators of dependable ground water and surface-water yields and of changing hydrologic conditions. Land use that reduces

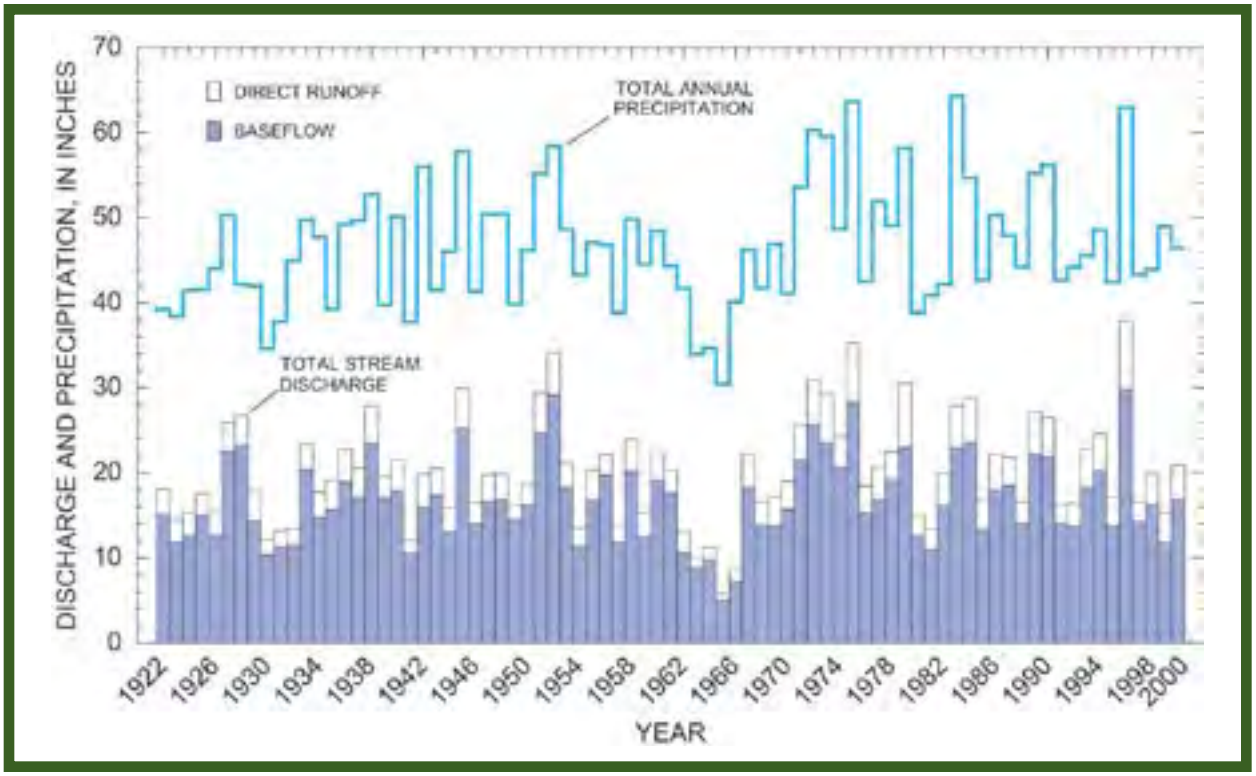


Figure 2-10. Relationship of streamflow and precipitation. The direct relationship of annual precipitation to stream discharge for the Pequest River at Pequest, New Jersey, is representative for most of the Highlands. Approximately half of the precipitation that falls on the watershed leaves as stream discharge. As precipitation increases total discharge also increases; however, the percentages of the components of total streamflow (baseflow and runoff) vary only slightly.

evapotranspiration (by deforestation, for example) and reduces infiltration (by creation of impervious surfaces) consequently increases the amount of runoff, thereby contributing to increased flood levels. The percentage of streamflow that is composed of baseflow and runoff can be modified by land-use changes that reduce recharge to ground water by increasing surface runoff. These changes can include new buildings, paving, soil compaction, and results of other human activities.

WATERSHED CONDITIONS

To evaluate existing conditions on a watershed scale and potential changes to watershed hydrology based on future change scenarios (Section 3, Changes in Water Resources), a computer simulation model was used. The model used was developed by the U.S. Geological Survey in cooperation with the New Jersey Office of State Planning, for the purpose of defining streamflow characteristics associated with 820 biologic monitoring sites in New Jersey. The watershed model incorporates long-term climate, topography, soils, impervious surface, and water withdrawal data and is calibrated to existing long-term stream gauge data (Kauffman 2001).

The model is suitable for use in the Highlands regional study because it provides water budgets for a large part of the study area including all of the New Jersey Highlands and the New York part of the Passaic River Basin. Because sufficient data were unavailable for the rest of the New York portion of the Highlands, the modeled area was limited to 1,456 square miles or 932,141 acres of the 1.4 million-acre Highlands study area. Water budgets were analyzed at watershed and subwatershed scales related to previously defined Hydrologic Unit Codes (Ellis and Price 1995). Hydrologic Unit Codes (HUC) are used to identify the boundaries and the geographic area of watersheds for the purpose of water-data management. The largest drainage area is HUC 8, which corresponds to the entire surface water drainage area for major river basins as shown in Figure 2-5. These large drainage basins have been further subdivided into smaller watersheds (HUC 11) and subwatersheds (HUC 14) that drain specific reaches of streams and tributaries within the larger basin. The model was used to predict water budgets for HUC 11 and HUC 14 basins within the modeled area. HUC 11 watersheds within the Highlands region have an average area of about 50 square miles and a maximum area of 150 square miles. There are 30 HUC 11 watersheds that are wholly or partially within the modeled area of the Highlands. In contrast, HUC 14 subwatersheds have an average area of 8 square miles and a maximum area of 20 square miles. There are 182 HUC 14 subwatersheds in the modeled area.

Figure 2-11 shows the regional difference in baseflow characteristics of HUC 14 subwatersheds and provides a basis for the evaluation of existing hydrologic conditions. Baseflow is a good indicator of the water-yielding capacity of the underlying aquifer and the stream's ability to sustain flow. The percentage of streamflow composed of baseflow for streams within each subwatershed was

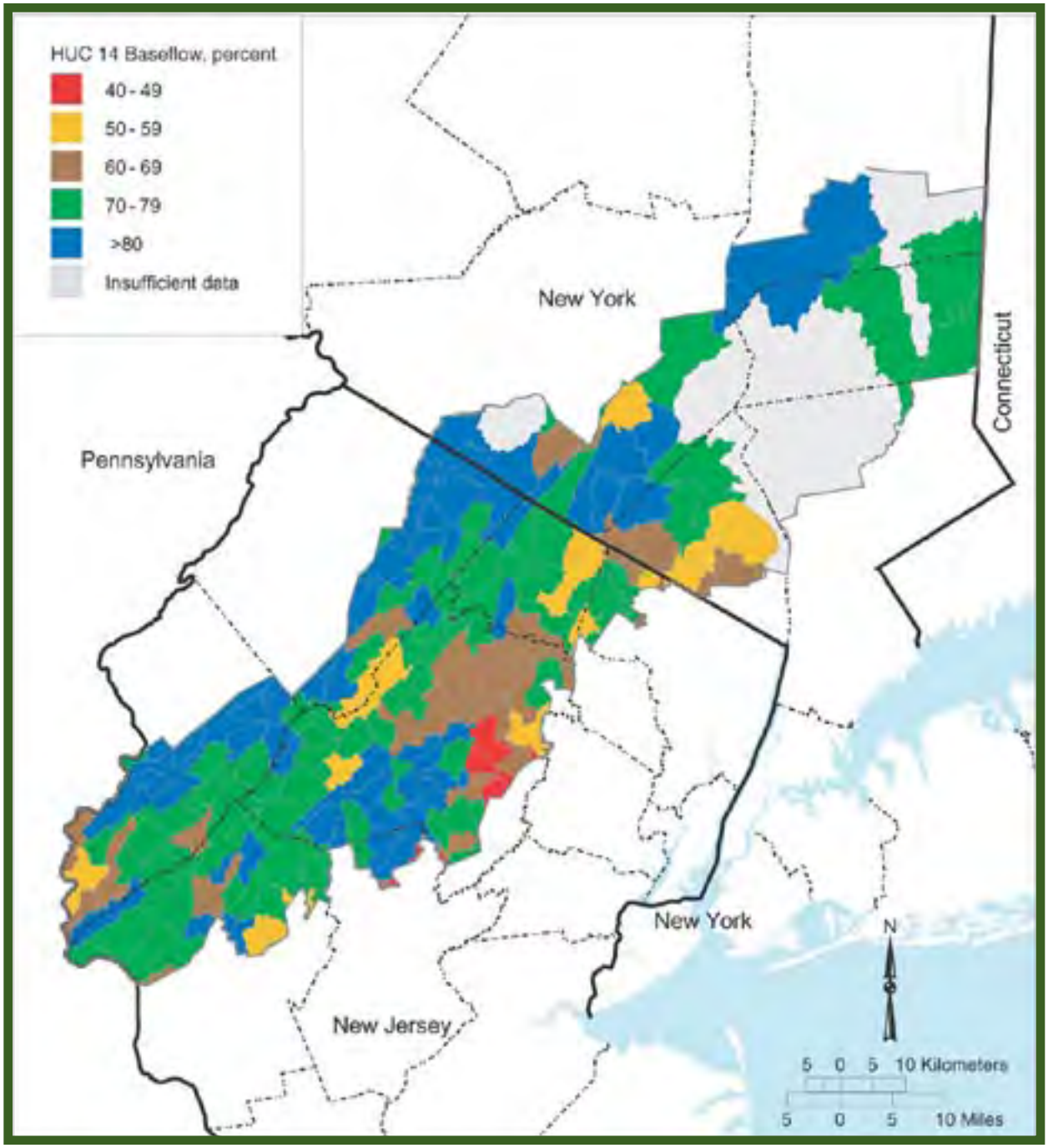


Figure 2-11. Variations in baseflow by subwatersheds. Regional differences in the amount of baseflow in Highlands streams during 1995 are related to the geology and degree of development within HUC 14 subwatersheds. The percentage of baseflow in relation to total streamflow indicates the water yielding capacity of an aquifer and a stream's ability to sustain flow. Baseflow is greatest in areas with carbonate and glacial aquifers and with the least urbanization. Hydrologic Unit Code 14 subwatersheds cover an average area of 8 square miles.

calculated from model-generated water budgets using 1995 water withdrawals and impervious surface data. The percentage of baseflow to total streamflow calculated from long-term streamflow data is also provided for larger watershed areas in New York where gauging data were available.

Model results and calculations indicate that, on average, baseflow comprises 73 percent of streamflow over the Highlands study area. The amount of baseflow in a stream depends mainly on the geology and type of development in the watershed. In rocky areas with little or no soil cover, the ground water contribution to streamflow is small because ground water storage capacity is minimal. In areas with thick glacial deposits or carbonate rocks with solution channels that can store large amounts of water, or both, the ground water contribution to streamflow is large. Figure 2-11 shows that baseflow accounts for more than 80 percent of total streamflow in many of the watersheds along the western boundary of the study area. These watersheds are underlain by a high percentage of carbonate and glacial aquifers (Figure 2-1) and include areas of highest aquifer recharge as noted in the 1992 Highlands Regional Study report (Michaels and others 1992). Areas where baseflow accounts for less than 50 percent of streamflow occur in some of the most urbanized areas of the study area with documented large ground water withdrawals, including parts of Rockland County, New York, and eastern Morris County, New Jersey.

In addition to providing an evaluation of existing conditions, water budget analyses are an important tool in evaluating the effect of future land use change, development, and water withdrawals on Highlands water resources. This evaluation is provided in Section 3, under Changes in Water Resources.

KEY FINDINGS:

- **Regionally, the Highlands study area receives about 5,300 Mgal/d of water from precipitation. The Highlands loses about 50 percent or 2,665 Mgal/d from river and stream outflows and about 9 percent or 428 Mgal/d from consumptive water use. An estimated 41 percent or 2,153 Mgal/d is lost by evapotranspiration.**
- **On a watershed scale, the amount of precipitation varies** geographically across the region and ranges **from about 44 to 52 inches per year.** Annual precipitation has varied from these averages by as much as 10 to 20 inches during unusually wet or dry periods.
- Total streamflow recorded by long-term gauging stations within the Highlands show that **during periods of prolonged drought, total annual streamflow can be as much as 40 to 70 percent less than long-term average annual totals. During unusually wet years, streamflow can be as much as 70 to 90 percent greater than long-term averages.** These climatic variations have an effect on the quantity and quality of water to downstream users.
- **Baseflow and runoff characteristics of streams are two of the most important components of the water budget analyses of Highlands watersheds.** Changing streamflow characteristics are strong indicators of changing watershed conditions.
- A watershed model used to simulate streamflow characteristics and provide water budgets for 182 HUC 14 subwatersheds indicates, that on average, **baseflow comprises 73 percent of streamflow over the Highlands study area. The percentage of baseflow to total streamflow depends mainly on the geology and degree of development in the watershed. Baseflow accounts for more than 80 percent of streamflow in many watersheds underlain by a high percentage of carbonate and glacial aquifers** that have relatively high recharge rates and water storage capacity. Areas where **baseflow accounts for less than 50 percent of streamflow** occur **in some of the most urbanized areas within the Highlands with documented large ground water withdrawals,** including Rockland County, New York and eastern Morris County in New Jersey.

Forest

While the Highlands contain a diversity of land uses, more than half of the study area is forest land. Most of the Highlands forest land is dominated by oak-hickory forest with northern hardwoods, hemlock, and swamp hardwoods being of secondary importance. The most recent USDA Forest Service Inventory and Assessment reports suggest that the amount of forest land classified as timberland is holding steady and that the total net volume of timber stock is growing as Highlands forests continue to mature (Alerich and Drake 1995, Griffith and Widmann 2001).

Forest Land Ownership and Management

The most current data on forest land ownership in the Highlands region comes from surveys conducted by the USDA Forest Service in New York and New Jersey in the early 1990s. There were between 50,000 and 75,000 private forest land ownerships in the counties of the Highlands region in 1991. A majority of Highlands forest land is owned by private individuals and organizations, with the remainder owned by public agencies. The diversity of reasons for owning forest land in the Highlands matches the diversity of people that own it. While many owners have forest land simply because it is a part of their residence, a significant proportion of forest land is owned as a real estate investment. These individuals and other owners in the Highlands region will determine how the land will be used and what the rest of society may expect from these lands: whether they will remain forested and replenish and purify ground water, or will be subdivided and developed into house lots with increased impervious surface cover. Decisions to change land use will depend on landowners' goals and whether they can afford these goals, given their property taxes and ability to generate income from the land.

Surveys found that these landowners value the forest land more for its green space than for its ability to produce timber products (Birch 1996). Most forest land ownerships are quite small with more than 50 percent of them smaller than 10 acres, and more than 90 percent smaller than 50 acres in size. Nearly a third of the owners have harvested some type of forest product from their land—predominately firewood—for their own use, and an even larger portion plan to harvest in the future. Approximately 10,900 acres in New York and 5,600 acres in New Jersey are enrolled in the USDA Forest Service's Forest Stewardship Program that provides forest management plans for multiple forest resources (Appendix I). Forest tax laws in New York and New Jersey require that a forest management plan be prepared by a professional forester and that the plan be followed. New Jersey requires that at least $500 of income must be generated from the forest per year.

Most of the public lands are owned by State agencies, but a significant area is also owned by various local and Federal agencies. The authority and regulations used to purchase and manage the public lands makes the fate of these lands more predictable than that of the lands owned by private individuals and organizations. The publicly owned forest lands are predominately owned to provide the general public with clean drinking water and recreational opportunities and to provide habitat for wildlife and rare species, and are unlikely to be converted to other land uses.

FOREST HEALTH

The Highlands forests are negatively impacted by a number of forest pests and diseases. One of the more critical biological threats to the forest resources of the Highlands is the presence of the introduced pest, the hemlock woolly adelgid. A significant percentage of the Highlands eastern hemlock forest stands have been infested and have died. As the primary evergreen tree in the Highlands, hemlock represents an irreplaceable component of Highlands forests. Defoliation caused by the gypsy moth has been impacting Highlands forests for many years, with oak forest types being the most affected. Several years of repeated defoliation leave the trees vulnerable to other insects and diseases that can eventually lead to tree mortality. This may ultimately lead to the reduction of the larger mature oak species in a particular area.

The incidence of many forest pests is monitored and updated on an annual basis through the USDA Forest Service's Cooperative Forest Health Program and the Forest Health Monitoring Program in each State. Efforts are underway on a variety of fronts to understand and mitigate the impacts of forest pests. Considerable effort is being focused on the use of biological agents to control some of the pest species including hemlock woolly adelgid and the gypsy moth. Other possible avenues include spray programs to abate the impacts of several of the pests including the gypsy moth.

Deer also pose a serious threat to forest health and regeneration as well as to the future vegetation composition of the Highlands forests. Deer actively browse tree seedlings and saplings and understory shrubs and herbs. Deer overpopulation and lack of adequate forage have resulted in low regeneration for native trees and herbaceous plants throughout the region. In many instances, preferential browsing on native species has given invasive plant species the competitive advantage to reproduce and spread unabated throughout the area.

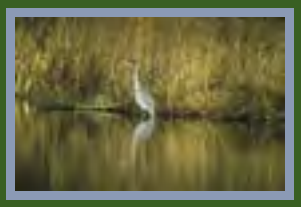
The individual impact from various forest stressors is partially dependent on additional contributing factors. One of the more recent significant factors is drought, especially since the early 1990's. Drought-stressed trees are more vulnerable to pests and diseases, and multiple stressors increase the probability of tree mortality. For example, the coincidence of drought and gypsy moth

outbreaks could significantly affect the oaks that make up a majority of the Highlands forests.

For more information on timberland, forest land ownership, and forest health, refer to the New York – New Jersey Highlands Technical Report.

KEY FINDINGS:

- **Of the forest land in the New York – New Jersey Highlands counties, 84 percent is privately owned**, half of it in small lots (10 acres or less). Nearly 90 percent of owners live on or near their forest land; however, the larger the tract, the more likely it was that the owner lived farther away from their land.
- The overwhelming majority of Highlands landowners mentioned **aesthetics, enjoyment, or increased property value as the primary reason for owning forest land.** Although timber harvesting was not the primary reason for ownership, more than one-third of the owners have harvested timber products from their land. Approximately 50 percent plan harvests in the future.
- **Approximately 16,500 acres** (10,867 acres in New York and 5,627 acres in New Jersey) **is managed under the USDA Forest Service's Forest Stewardship Program.**
- The amount of forest land classified as **timberland** by the USDA Forest Service **is holding steady in the New York – New Jersey Highlands.** In New York Highlands counties, the amount of timberland decreased by approximately 7.5 percent from 1980 to 1993. In New Jersey Highlands counties, the amount of timberland increased by more than 6 percent during the 1987 to 1999 time period. This is due primarily to the gradual and increased conversion of farm and grassland to forest land over the period.
- **Of the timberland, 53 percent is in the oak-hickory forest type**, followed by 25 percent in northern hardwoods.
- **The net timber volume grew by more than 24 percent** during the 1980's and 1990's. **The annual removal is less than half of the net growth** of sawtimber and growing stock.
- As of 1998, about **30 percent of the approximately 20,000 acres of hemlock stands in New Jersey showed evidence of hemlock woolly adelgid infestation**, with approximately 5,000 acres showing severe to complete defoliation (Royle 2002).
- In 2001, more than **100,000 acres of forest land (12 percent) were defoliated by gypsy moths**, primarily in the New Jersey portion of the Highlands with less damage in New York.



BIODIVERSITY

Biological diversity, or biodiversity, is the variety as well as variation of all living organisms in the context of their habitats and ecological systems. Components of biodiversity include individual species and the genetic variation within and between species, ecological diversity and the variety of different systems, and the linkages at the regional scale. The Highlands are rich in the variety of biological systems that support high local biodiversity including freshwater wetlands, swamps and bogs, glades, ravines and ridges, large contiguous forest tracts, and grasslands. The rich diversity of different community types as well as variability within the community types allows the Highlands region to support high levels of biodiversity.

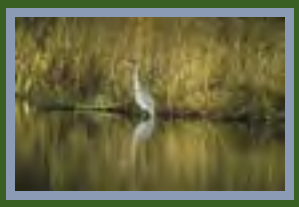
FISH AND WILDLIFE

The Highlands represent a rich habitat resource for fish and wildlife. The combination of relatively large tracts of forest and the variety of habitat types in the Highlands support a wide diversity of fish and wildlife. There are more than 100 species of nesting birds, large mammals including bobcat, black bear, and river otter, and wild trout fisheries in the Highlands. The Highlands is also part of a major east coast migratory flyway for many bird species.

About 874,000 acres or 62 percent of the Highlands is considered to be important wildlife habitat (Figure 2-12). Large forest tracts are one of the critical habitat types for Highlands wildlife. Just as important as the sheer size of this habitat are its location and contiguity (Figure 2-13). Large, unbroken tracts of forest (larger than 500 acres), which comprise about 350,000 acres or nearly 25 percent of the Highlands, support habitat requirements of far-ranging mammals such as bear and bobcat, and provide interior forest habitat critical to the survival of many nesting neotropical songbirds. In addition, protected open space areas in key locations provide feeding and migration corridors that are critical to the survival of large animals with extensive range requirements. Streams provide a critical resource base for trout fisheries. There are 1,861 miles (or 45 percent) of streams in the Highlands that provide the necessary habitat requirements to support trout.

ENDANGERED AND THREATENED SPECIES

The Highlands region harbors over 200 species of plants and almost 50 species of vertebrate animals that are listed on Federal or State inventories for species that are endangered, threatened, or of concern. Over 50 percent of the land within the Highlands provides habitat for wildlife species that have special status at the State or Federal level, while another 10 percent of the Highlands provides



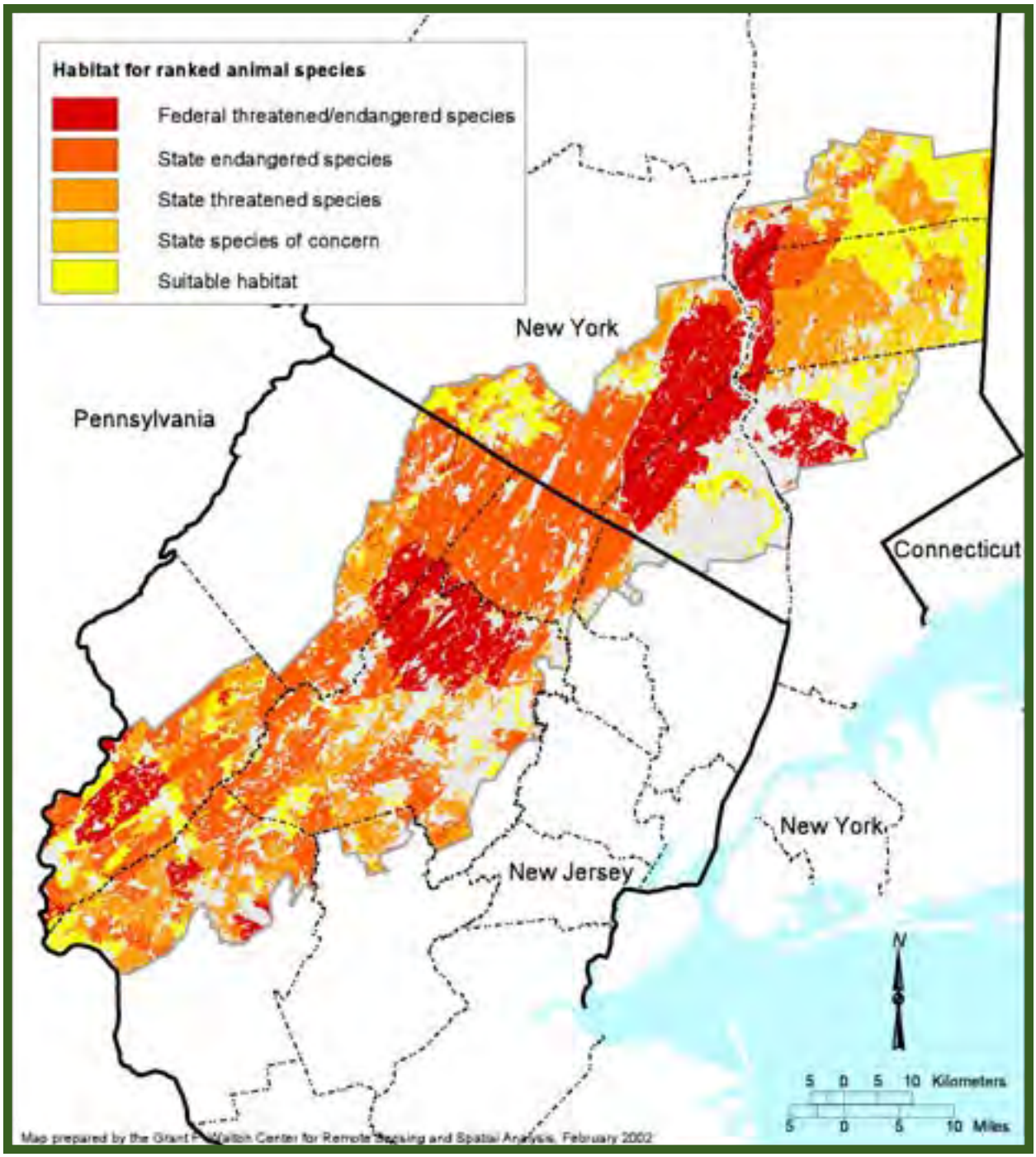


Figure 2-12. Threatened and endangered wildlife habitat. Critical areas shown on the map provide habitat for wildlife species that have special status at the Federal or State level. Over 60 percent of the Highlands is considered important wildlife habitat.

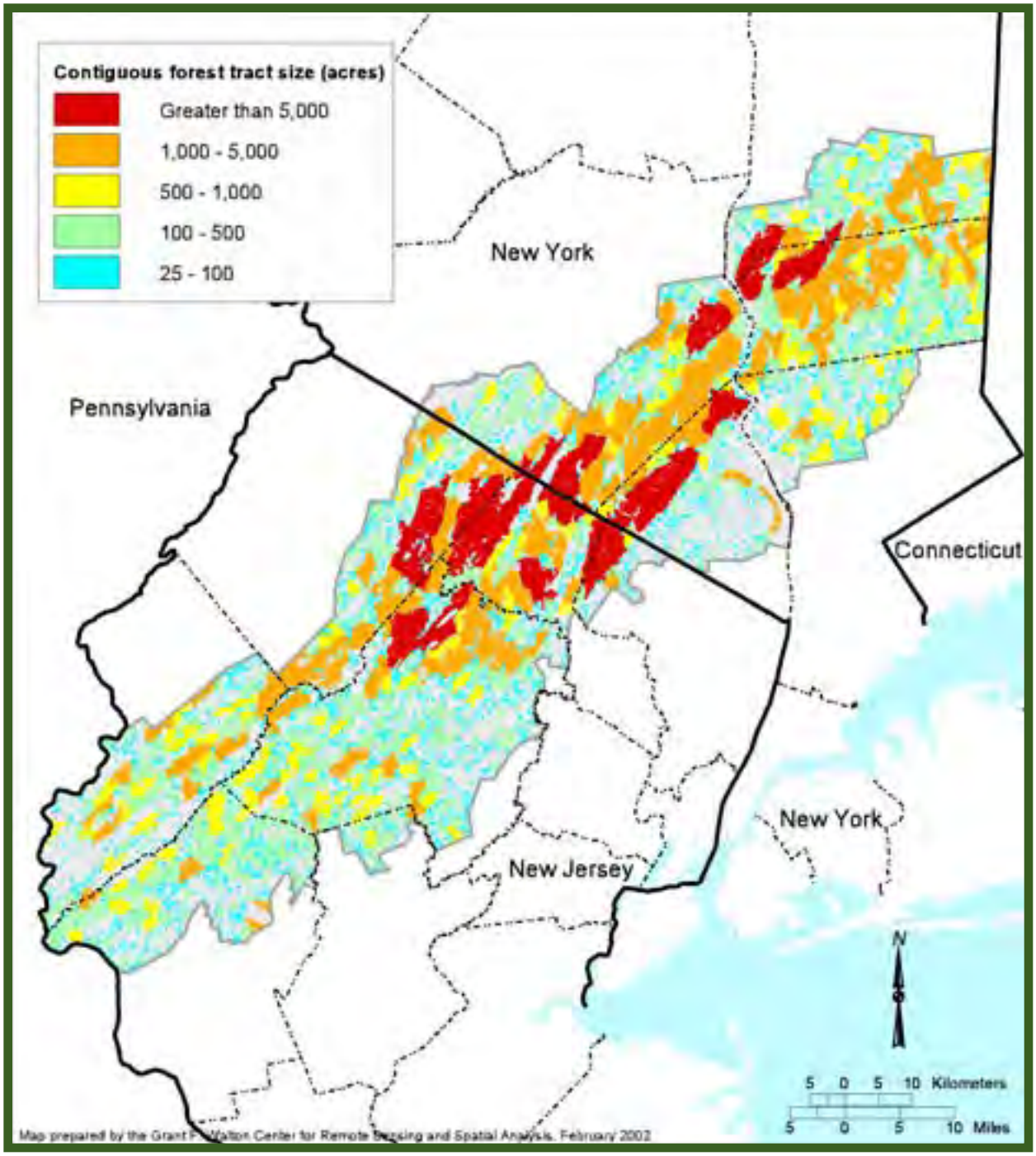


Figure 2-13. Contiguous forest tracts. These large contiguous forest tracts provide habitat for species that are area sensitive and require large tracts of land. Almost 25 percent of the Highlands is in forested tracts of 500 acres or more.

important wildlife habitat (Table 2-3). In addition, over 100,000 acres or 7.5 percent of the Highlands provides habitat for plant species that are listed as imperiled at the State or Federal level (Figure 2-14, Table 2-4).

Endangered species are in immediate peril due to low population numbers as a result of one or several reasons including habitat loss, over-exploitation, predation, competition, disease, disturbance, or contamination. Federally listed endangered species represent those species that are in peril at the national level. State listed endangered species are those that are not nationally at risk but are rare within the State. Species listed as threatened are those at risk of becoming endangered if trends continue and management efforts are not successful in increasing population numbers. Species of concern are of interest at the State level and represent those species whose population trends suggest that if they continue, they will become threatened and potentially endangered.

Endangered or threatened species within the Highlands region include Federally listed species such as the bog turtle, bald eagle, Indiana bat, and swamp pink. State listed endangered and threatened species in the Highlands include the timber rattlesnake, wood turtle, red-shouldered hawk, barred owl, great blue heron (breeding), and eastern wood rat. There are also several globally rare species in the Highlands including Torrey's mountain mint, New England bluet, and the triangle floater. For detailed methodology on mapping of biodiversity in the Highlands, see the New York – New Jersey Highlands Technical Report.

Natural Communities

There are a number of unique and exemplary natural communities in the Highlands region (Table 2-5). Analyses show that approximately 282,350 acres (19 percent) of the Highlands have State and Federal status recognition as priority sites for preservation or role-model examples of relatively intact vegetation community types that are in good condition, relatively undisturbed, and generally lack invasive species (Table 2-5, Figure 2-15). These communities are important biodiversity components of the Highlands, as in many cases they are habitat to sensitive or rare species found in only a few locations throughout the region. Special community types include calcareous fens, glacial bogs, rocky summit or outcrop plant communities, talus slope woodlands, swamps including Atlantic white cedar and spruce-fir, and prime examples of chestnut oak forests and hemlock-northern hardwood forest.

Large contiguous tracts of relatively natural habitat provide critical habitat and movement corridors for wide-ranging species (Figure 2-13). In 2001, The Nature Conservancy identified seven of these tracts of contiguous forest as their regional priority for conservation.[1] These so-called matrix sites of exceptional biodiversity and integrity comprise 200,000 acres.

[1]Unpublished GIS data on file, The Nature Conservancy, Newton, New Jersey.

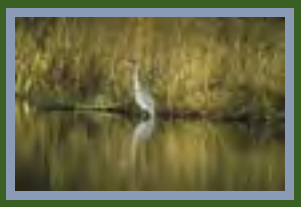


Table 2-3. Habitat area for imperiled wildlife species in the Highlands, by conservation status

Status	Acres*	Percent of study area
Federal Threatened and Endangered Species	195,488.3	13.78
State Endangered	310,262.7	21.87
State Threatened	198,440.3	13.99
Unprotected Species of Concern	15,425.9	1.09
Potential habitat	153,003.7	10.78
Total NY/NJ Region	**1,418,825.0**	--

*Section 3, Resources at Risk, identifies how many acres of land ranked highest for biodiversity values are protected and unprotected.

Table 2-4. Habitat area for imperiled plant species in the Highlands, by conservation status

Status	Acres*	Percent of study area
Federal Threatened and Endangered Species	2,878.7	0.20
State Endangered	72,345.0	5.10
State Threatened	29,902.2	2.11
Unprotected Species of Concern	6,827.0	0.48

*Section 3, Resources at Risk, identifies how many acres of land ranked highest for biodiversity values are protected and unprotected.

Table 2-5. Important natural community areas in the Highlands, by ranked biodiversity status

Biodiversity Rank*	Acres**	Percent of study area
2	50,973.8	3.6
3	30,250.0	2.1
4	63,398.7	4.5
5	138,527.0	9.8

*Biodiversity rank of 1 is highest value and rank of 5 is lowest value. In the study area, no community was ranked 1.

**Section 3, Resources at Risk, identifies how many acres of land ranked highest for biodiversity values are protected and unprotected.

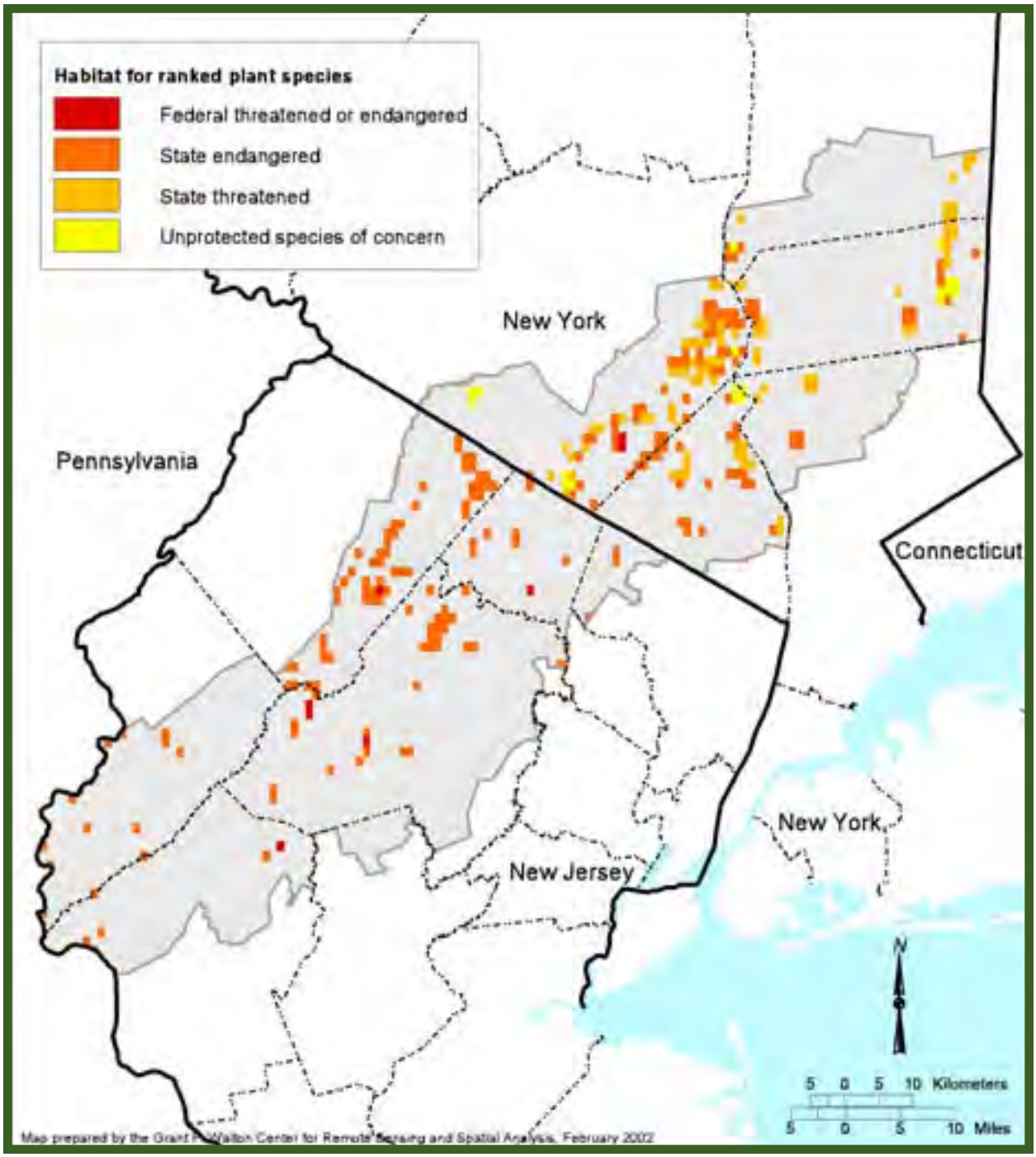
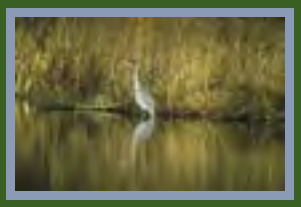


Figure 2-14. Threatened and endangered plant habitat. More than 7 percent of the Highlands provides habitat for threatened and endangered plant species.



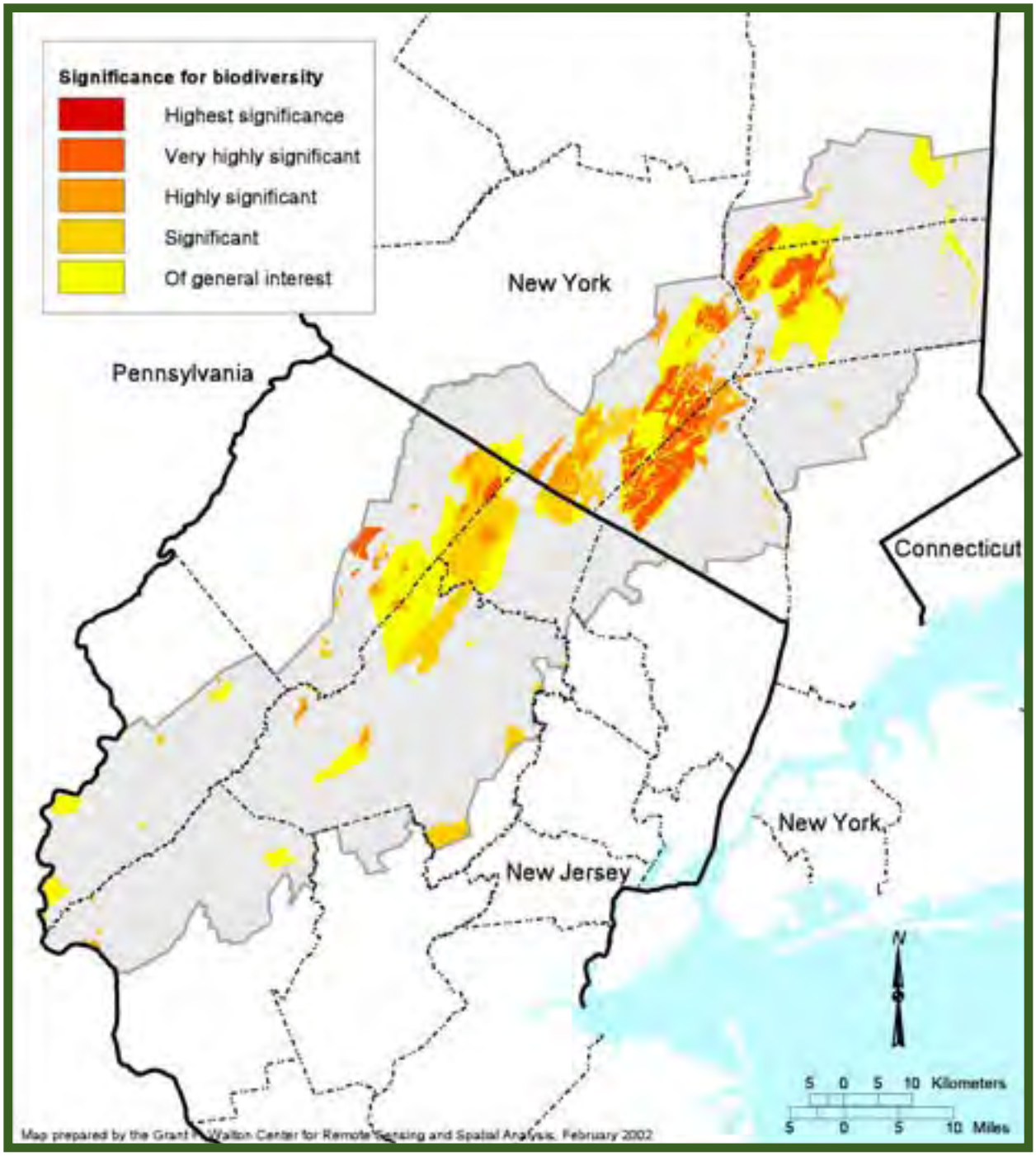
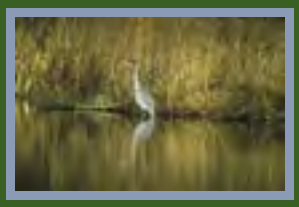


Figure 2-15. Important natural communities. Natural communities that are important to the biodiversity of the Highlands may represent unique assemblages of plants and animals, be rich in biodiversity, or be large tracts of representative habitat types that are relatively undisturbed.



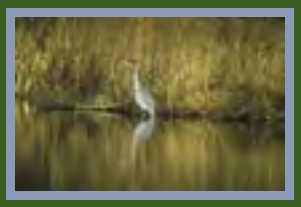
MIGRATORY FLYWAY

The Highlands represent a vital link in a major bird migratory flyway connecting wintering habitat in Central and South America with breeding grounds in northern latitudes. One-quarter of all neotropical bird species found in the United States are found in the Highlands, and half of the total number of species that breed in the Highlands are neotropical migrants. Many of these species are forest-interior breeding species, and the 416,182 acres of interior forests in the Highlands provide critical habitat for species including the red-eyed vireo, American redstart, and eastern pewee.

Two-thirds of the migrant birds that use the eastern migratory flyways are believed to be in serious decline. Several species including the wood thrush, Kentucky warbler, black-throated blue warbler, and cerulean warbler are on the Audubon Watch List for species in rapid decline (National Audubon Society 2001). Population declines have been primarily attributed to the loss of habitat through forest fragmentation and development pressure. Additional causes of bird population declines in the Highlands include exposure to human-derived contaminants, increased competition with nonnative bird species, increased predation from domesticated animals, and collision with structures.

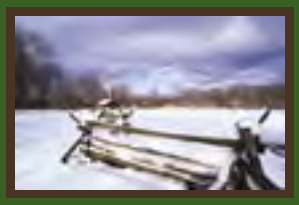
INVASIVE SPECIES

Invasive species can dramatically affect species diversity and ecosystem function. Some of the more common invasive plant species in the Highlands include Norway maple, tree-of-heaven, Japanese barberry, Japanese honeysuckle, purple loosestrife, garlic mustard, and stilt grass. In addition, the soil community has been impacted by the invasion of exotic earthworms throughout the region. Range expansion of cowbirds exacerbates the effects of forest fragmentation on forest interior breeding birds. The hemlock woolly adelgid, an insect pest that specifically targets eastern hemlocks, has spread throughout the Highlands. As the Highlands' primary evergreen tree, hemlocks represent a keystone species providing habitat diversity for nesting birds and dense shade to maintain cool stream water temperatures for trout. Little scientific evidence is available as to how many of these invasive species are altering the biodiversity of the Highlands; however, the community structure and ecosystem function will inevitably change in the presence of these invaders.



KEY FINDINGS:

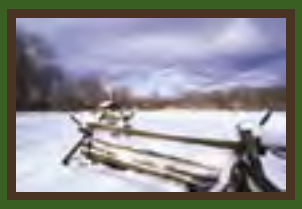
- There are **over 250 species** of plants and animals in the Highlands that are **considered to be in peril** due to declining population numbers. There are 3 Federally listed endangered species in the New York – New Jersey Highlands and 118 State listed endangered species.
- The **diversity and arrangement of different habitat types** in the Highlands creates an important mosaic that **supports the high species biodiversity** of the Highlands region.
- **Large contiguous forest** tracts (greater than 500 acres) provide critical habitat resources for many species. These large forest tracts cover approximately 350,000 acres (25 percent) of the Highlands. **There are only 11 tracts of forest that are greater than 5,000 acres.** These largest tracts comprise approximately 60 percent of the New York – New Jersey Highlands core forest interior habitat. **The survival of large mammals**, such as black bear, and furbearers, such as bobcat and river otter, **depends on maintaining contiguous habitat** throughout the Highlands. Contiguous habitat provides migration corridors, and extends the feeding and breeding range of these populations.
- Over **280,000 acres of the Highlands have received special status for containing important natural community or high biodiversity areas or both.** These communities contribute significantly to the biotic integrity of the New York – New Jersey Highlands. **Protection of important natural communities** extends beyond protection at the species level and **protects multiple factors** at the community and regional level.
- **The Highlands serve as a major migratory flyway for many neotropical bird species**, many of which populations are in decline. Of particular concern to ornithologists are the 70 to 75 species of interior nesting neotropical migrants such as the red-eyed vireo, American redstart, Kentucky warbler, and eastern pewee. These species require large undisturbed forest patches.
- **Fragmentation and alteration of habitat continue to pose the greatest threat** to the biological communities in the Highlands. The rapid expansion of urbanization encroaches on and fragments habitat, destroys individuals as well as populations, and potentially threatens the continued existence of many biological communities. Degradation of habitat by direct destruction or indirectly through pollution, erosion, introduction of invasive species, or fragmentation threatens the existence of species, diminishes natural communities, and reduces genetic variability.



FARMLAND

Although normally considered a "land use" and not a resource, agricultural land within the Highlands is essential to the area's future. Approximately 10 percent of the Highlands is in agricultural land use such as cultivated cropland, orchards, nurseries, pasture, and hay fields (Figure 2-16). Farming has been declining in the Highlands counties of New York and New Jersey for more than half a century with a steep decline in farm acreage occurring between the 1940s and the 1970s. County level agricultural statistics show that between 1969 and 1987, agricultural land use decreased by 25 percent with almost 90,000 acres abandoned or developed. From 1987 to 1998, farmland decreased by another 39,000 acres or 15 percent. While it appears that the steep decline in acres of farmland is stabilizing, it is projected that farmland will continue to be converted to other land uses without aggressive farmland preservation programs.

Agriculture sustains the intrinsic natural character of the working rural landscape and provides jobs and a sustained quality of life for many landowners and residents of the Highlands. Farms and the agricultural production sector contribute to the region's economy and promote a broader base of economic activity. All residents benefit from the quality and abundance of locally grown products as well as the opportunity to connect with the farming life through the growing industry of farming tourism (e.g., vegetable, fruit, and pumpkin picking; hayrides; corn mazes). To protect the Garden State's agricultural heritage, New Jersey has a goal of preserving 500,000 acres through the Farmland Preservation Program (New Jersey Department of Environmental Protection Green Acres Program 1999b). In the New York Highlands, approximately 6,500 acres of productive farmand have been protected through the Farmland Protection Trust Fund. The maintenance of large contiguous blocks of farmland is necessary to ensure the productivity and economic health of agriculture over the long term. Preserving large contiguous blocks of farmland will help to preserve the character and quality of the region's rural landscape. For more information on farmland, refer to the New York – New Jersey Highlands Technical Report.



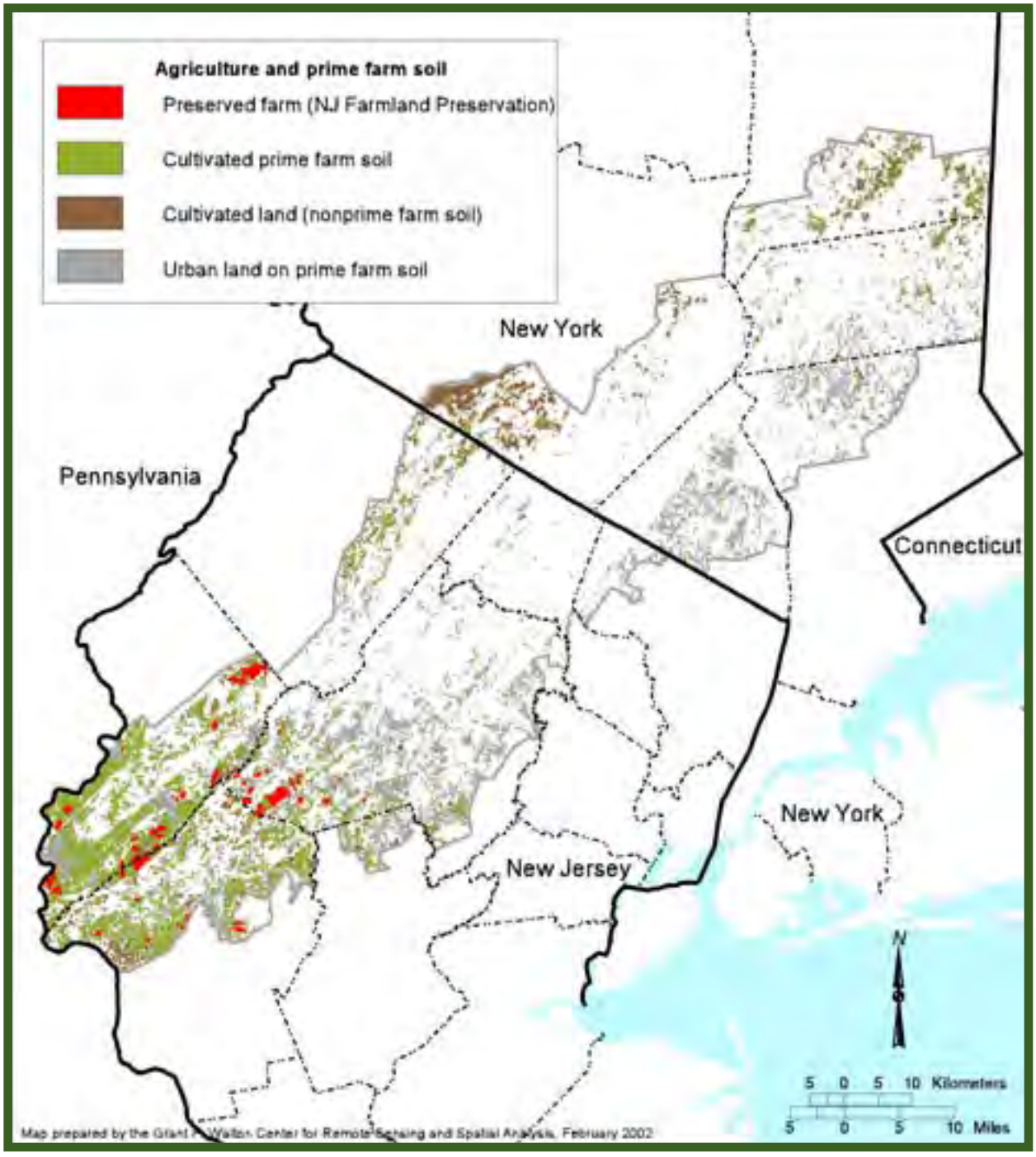
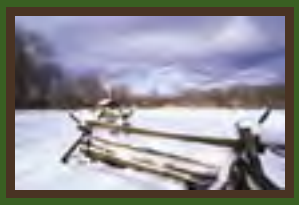

Agriculture and prime farm soil
Preserved farm (NJ Farmland Preservation)
Cultivated prime farm soil
Cultivated land (nonprime farm soil)
Urban land on prime farm soil
New York
Pennsylvania
Connecticut
New York
New Jersey
N
5 0 5 10 Kilometers
5 0 5 10 Miles
Map prepared by the Grant F. Walton Center for Remote Sensing and Spatial Analysis, February 2002

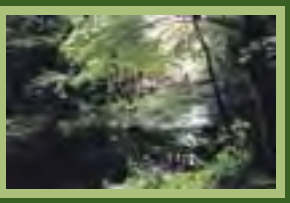
Figure 2-16. Agricultural resources. About 60 percent of cultivated land was on prime farm soil in 2000, and about 112,000 acres of prime farm soil had been lost to urban development.



FARMLAND: KEY FINDINGS

KEY FINDINGS:

- **Approximately 10 percent of the New York – New Jersey Highlands region or more than 143,000 acres of land is in agricultural land use.** Approximately 74 percent (over 106,000 acres) of this agricultural land was in New Jersey and 26 percent (over 37,000 acres) was in New York.
- **The size of most farms is in the 10-49 acre size class**, and they are primarily located in Warren, Hunterdon, and the very eastern part of Sussex County in New Jersey, and Orange, Dutchess and Putnam Counties in New York. Not all farmland is owned by farmers.
- **Farm production is varied** and includes these products: Livestock and poultry such as beef cows, milk cows, horses and ponies, hogs, sheep, chicken; and crops such as corn (grain, seed, and silage), soybeans, hay, vegetables, orchards, fruits, nuts, berries, nursery and greenhouse crops, mushrooms and sod (National Agricultural Statistics Service 1999; New York Agricultural Statistics Service 2001).
- **In New Jersey** the Farmland Preservation Program, which funds farmland easements on a willing seller-willing buyer basis, has been overwhelmingly supported by voters and more than **9,550 acres have been protected. In New York** through the Farmland Protection Trust Fund, **approximately 6,500 acres of productive farmland have been protected.** Additional farmland in both States has been protected by private nonprofit land trusts through outright purchase or through conservation easements.
- Over 60 percent (87,678 acres) of the actively cultivated land is located on mapped prime farm soils. **There has been a significant loss of prime farmland with approximately 111,600 acres of prime soils that are now in developed land uses.**



RECREATION

Open spaces in The New York – New Jersey Highlands provide numerous opportunities for both passive and active outdoor recreation. The Highlands hills, forests, lakes, and streams give the metropolitan region's 20 million citizens a chance to escape to nature within a 1- to 2-hour drive from home. There are more than 311,000 acres of local, county, State, and Federal parks in the Highlands (Figure 2-17). The attendance at Highlands major outdoor recreational venues is over 14 million visitor days per year. This level of visitation is greater than the visitation at such famed national parks as Yellowstone, Yosemite, and Grand Canyon. The region's parks and trails provide outdoor enthusiasts everything from short walks to long-distance excursions (Figure 2-18).

The Highlands extensive network of rivers, streams, lakes, and reservoirs makes it one of the more popular fishing destinations in the region. In addition to the Highlands' publicly accessible waters, private lakes and beaches provide opportunities for boating and swimming (Figure 2-19). While hunting has decreased slightly in popularity, public participation in nonconsumptive uses of wildlife such as bird-watching and wildlife viewing is on the rise, and both New York and New Jersey have established a network of wildlife viewing sites open to the public. Developed recreational facilities such as downhill skiing areas and golf courses are another important component of the outdoor recreational picture.

Population projections to the year 2010 indicate that the demand and need for open space and outdoor recreation opportunities will remain high (New Jersey Department of Environmental Protection Green Acres Program 1999a). It is estimated that an additional 47,000 acres of public parkland are needed to meet the Balanced Land Use Guidelines suggested by the New Jersey model for the six core counties in New Jersey alone (New Jersey Department of Environmental Protection Green Acres Program 1999a). These calculations were based on the assumption of no additional development. New Jersey's projected Statewide deficit for the year 2010 is 270,000 acres. However, New Jersey looked beyond these figures and set the ambitious goal of preserving an additional 1 million acres within the next 10 years (New Jersey Department of Environmental Protection Green Acres Program 1999b). The Highlands region is identified as a high priority area for meeting these open space demands (New Jersey Department of Environmental Protection Green Acres Program 1999a).

Similarly, in New York State, the Highlands are a focal point of open space and greenway planning and protection. The Hudson River and Highlands area of New York were designated as part of the Hudson River Valley National Heritage Area in 1996, recognizing the importance of the history and the resources of the Hudson River Valley to the nation. In 1991, the State of New York passed the Hudson River Valley Greenway Act of 1991 to create a regional planning process to promote the protection of the region's natural and cultural resources.

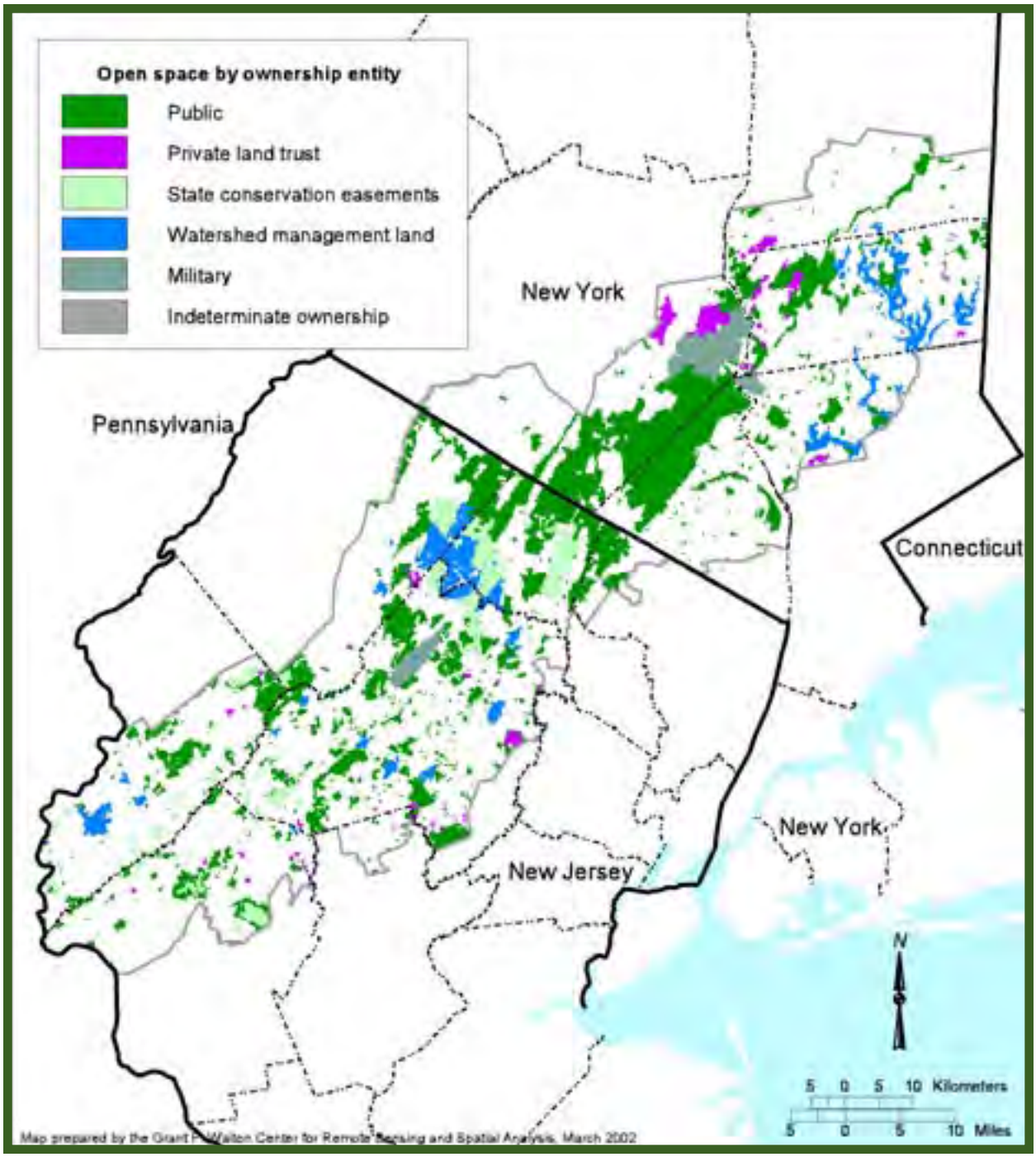
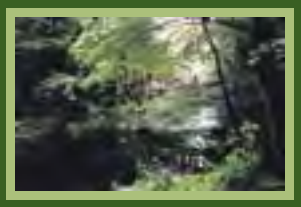


Figure 2-17. Ownership of open space. More than 311,000 acres of publicly and privately owned open space were found in the Highlands in 2001.



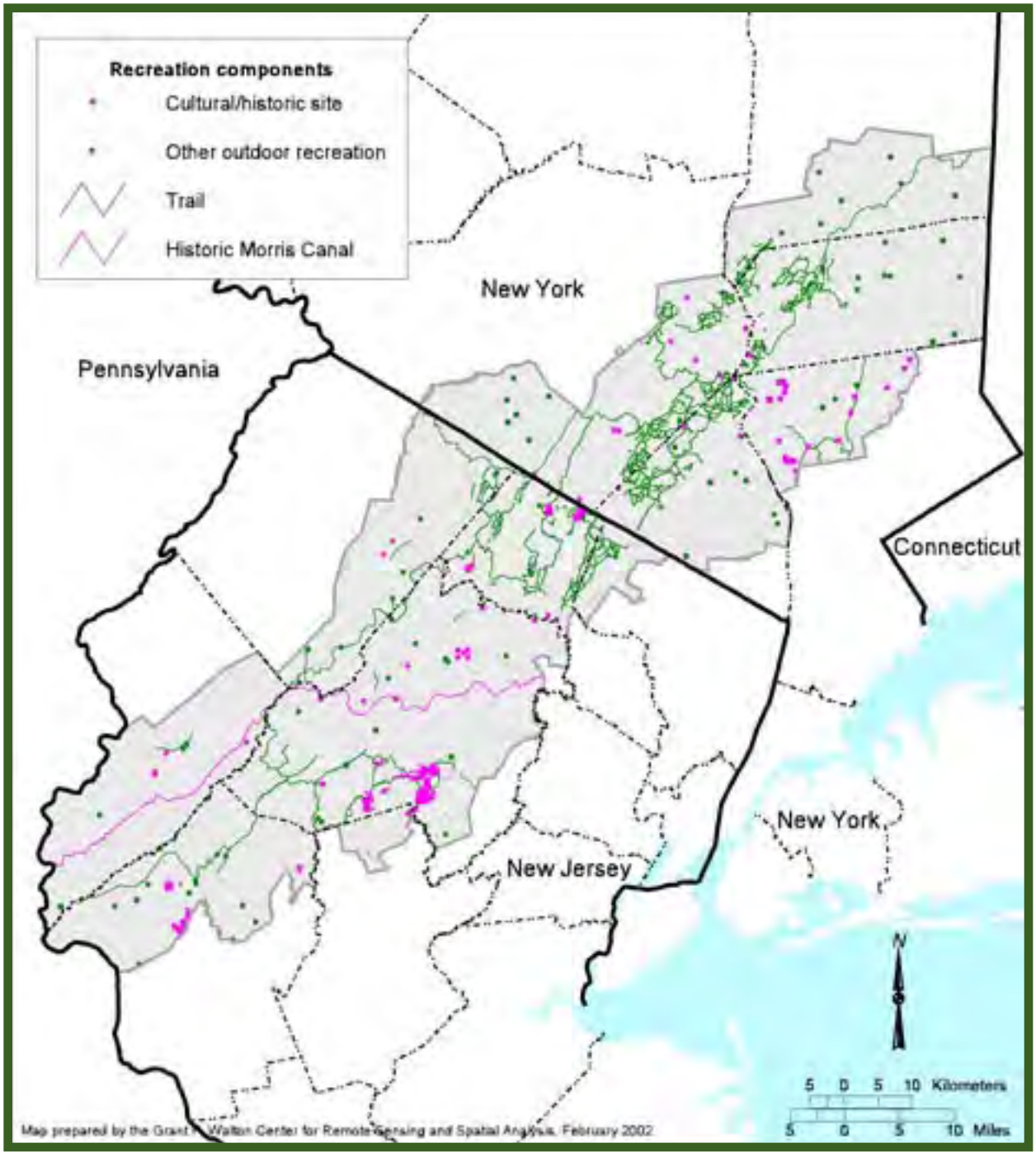
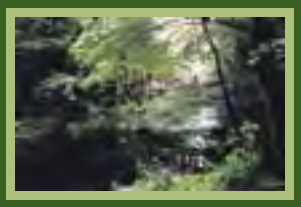


Figure 2-18. Trails, and cultural and historic sites. The Highlands contain a wealth of trails and cultural and historic sites.



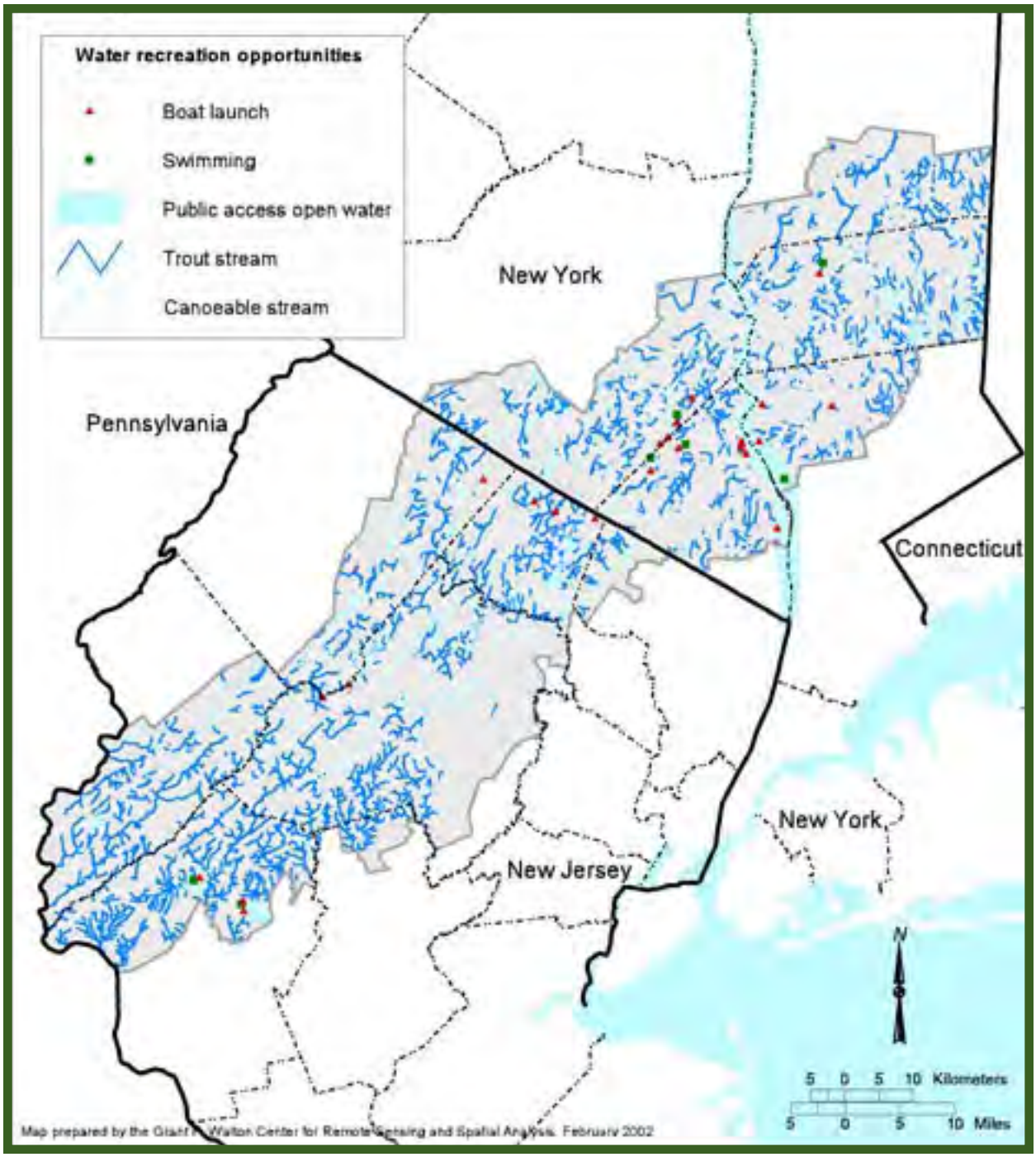
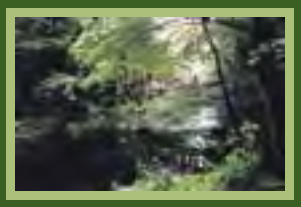


Figure 2-19. Water recreation resources. The opportunities for water-based recreation in the Highlands are many.

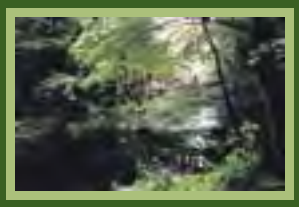


The Hudson River is also a designated American Heritage River, a Presidential Initiative to help communities revitalize their rivers and the adjacent shoreline. This is an umbrella initiative designed to more effectively use the Federal government's many resources through a plan that is designed and driven by local communities.

During the 1990's, a number of ambitious open-space efforts were initiated:

- Of special note was the acquisition of Sterling Forest Park through a partnership of Federal, State (both New York and New Jersey), and private entities. The initial purchase in 1998 of 15,280 acres has been supplemented by additional purchases, with more on the horizon. The park consists of nearly 20,000 acres of forest, lakes, streams and wetlands and contains significant historical and cultural resources.
- Through its Land Acquisition and Stewardship Program (initiated in 1997), the City of New York embarked on an ambitious campaign to purchase additional watershed lands to protect the water quality in the Croton Reservoir system. More than 4,500 acres have been protected to date. Where possible, compatible recreational uses such as hiking, fishing, and hunting will be allowed.
- The Pequannock Watershed lands (32,800 acres) in New Jersey, owned and managed by the City of Newark, provide important recreation and scenic values to the region. Since the 1992 Highlands Regional Study, New Jersey has purchased conservation easements to more than 15,500 acres of this land, protecting it from future development.

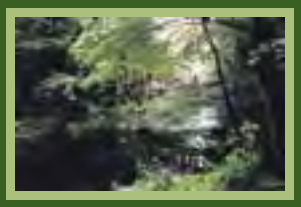
Recreation and open space are affected by the changes in population and land use in the Highlands. Land development, especially along major roadways and within the viewshed, can significantly affect the outdoor experience and its recreational economic value. Continued subdivision of land will make parkland acquisition more costly and access to private land less likely, and reduce the buffer that private open space provides to public parks.



RECREATION: KEY FINDINGS

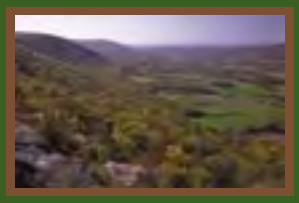
KEY FINDINGS:

- **More than 20 percent of the Highlands is in publicly or privately protected open space.** Of these 311,700 acres 5 percent is in Federal ownership, 56 percent in State parks, forests, and wildlife management areas; 19 percent is in watershed management or other conservation easements; 10 percent is in county parkland; 5 percent is in local parkland; and 5 percent is in nonprofit land trusts. These figures are based on best available data and may underestimate the amount of open space in local parks and land trusts.
- **More than 23,500 acres of military lands** including the Picatinny Arsenal, West Point, and Camp Smith Military Reservations are in the Highlands. Although a percentage of these areas are not physically accessible, these lands provide scenic and wildlife values.
- **More than 14 million people visit the Highlands** each year for outdoor recreational opportunities. This total is for attendance at State parks and forests in Morris, Orange, and Westchester counties, and Morristown National Historic Park, and does not include other county parks or Federal or State wildlife management areas. The total visitation for these parks rose steadily during the 1990's (from approximately 8 million to more than 14 million).
- **Almost 350 miles of linear recreational features** including such notable regional hiking trails as the Appalachian Trail, Highlands Trail, and Long Path are located in the Highlands. Many of the region's long-distance rail-trails and county greenways are multiple-use trails supporting bicycling, cross country skiing, and horse-back riding—in addition to walking. There are also more than 620 miles of local hiking trails. **Approximately 25 percent of local hiking trails are on private lands.**
- The Highlands contains **numerous historical and cultural resources** including Revolutionary War sites, such as the Morristown National Historical Park, West Point and Stony Point Battlefields, remnants of an earlier industrial past such as the Morris Canal and iron forges, along with historic farms, homes, and villages. While **165 sites were documented**, many more sites remain to be catalogued and mapped.
- With **1,860 miles of trout streams** in the Highlands, fishing is a popular recreational sport. The extensive network of cold-water trout fisheries throughout the Highlands makes it one of the more popular fishing destinations in the region. The region is also well-known for the warm and cold-water fisheries opportunities that the area's numerous lakes and reservoirs provide.



Recreation: Key Findings

- **The Highlands contain 535 miles of canoeable rivers.** In addition, there are **dozens of lakes and reservoirs** with public boat ramps and a spectacular stretch of the Hudson River that **provide fishing and boating opportunities to the general public.**
- Hunting has been a very popular recreational activity in the Highlands. There are **approximately 25,000 acres of public open space accessible for both small game and deer hunting.** Additional lands are owned and managed by private individuals and gun clubs with the primary purpose of recreational hunting. However, in recent years the number of hunting licenses sold has been on the decline and there is **concern that** as the primary deer control mechanism, **continued decline of hunting will result in increased deer overpopulation problems.**
- Golf is an increasingly popular outdoor recreational activity**. There are more than 40 golf courses in the Highlands.** Golf courses can have negative environmental impacts and must be carefully planned to minimize conflicts with other resource values.
- **More than 140,000 acres** of the Highlands' ridges and valleys, including the nationally significant Hudson Valley, **have exceptional scenic value.** There are more than 170 recreational trail viewpoints and lookout towers available for scenic viewing of the Highlands.



CONSERVATION VALUES ASSESSMENT

A Conservation Values Assessment model was developed to translate conservation priorities into geographic information. The geographic locations of the natural resources described above were mapped using geographic information system (GIS) technology. This GIS-based model was used to integrate these various sources of information to provide a coherent picture of relative resource conservation value across the region, highlighting areas that are a priority for conservation management. This assessment of conservation values updates and expands on a 1999 Priority Area Assessment conducted by the Regional Plan Association (2001).

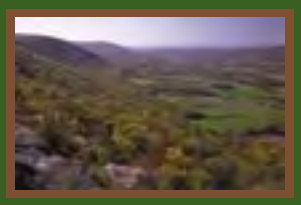
The GIS-based Conservation Values Assessment model weighed the conservation value of these various resources in two ways. First, the model was based on achieving the following goals for each of the five general resource types:

Maintaining an adequate supply of high quality water;
Conserving productive forest lands;
Conserving areas of high biodiversity and habitat value;
Conserving productive agricultural land; and
Providing adequate recreational opportunities for natural, historic and cultural resource-based uses.

Second, individual resources within each of the five general resource areas were assigned a value ranging from 0 to 5 (highest value) based on the following rules:

1. The greater degree to which conservation of the landscape would directly protect a resource or reduce the likelihood of negative impacts was ranked higher.
2. Lands that protect human health (e.g., drinking water) were ranked higher than lands that protect ecosystem health (e.g., trout production waters), which were ranked higher than lands that provide a resource for human use (e.g., trout maintenance waters).
3. Lands for which a significant public investment (e.g., publicly owned park land) has been made were ranked higher than lands for which no public investment has been made.

Figures 2-20 to 2-24 show the results of the analysis for each resource type, and Table 2-6 lists the corresponding acres. The values for all five resource types were mapped together to determine where the resource values overlap, that is, where the values for the different resources are the same (Figure 2-25). For example, areas with the highest resource value are where all the resources have a conservation value of 5. The total number of acres for each conservation value are as follows:



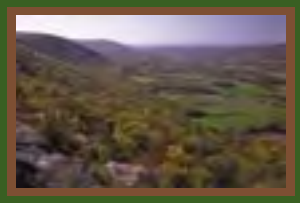
Conservation value	Acres	Percent of Highlands region
1 (lowest)	314,195	22.1
2	267,491	18.9
3	294,410	20.8
4	261,316	18.4
5 (highest)	280,687	19.8

In Section 3 under Resources at Risk, the results of the Conservation Values Assessment are further analyzed using maps of the existing network of publicly and privately owned lands in the Highlands. The results identify major clusters and large contiguous tracts that are unprotected; and because they had values of 4 or 5 in the Conservation Values Assessment, may deserve special consideration for future open space protection.

Table 2-6. Conservation values and area of resources in the Highlands

Value*	Water		Forest		Biodiversity		Farmland		Recreation	
	acres	%	acres	%	acres	%	acres	%	acres	%
0**	2,466		670,751		480,242		1,278,043		175,744	
1	195,217	13.8	103,390	7.3	166,500	11.7	23,279	1.6	152,747	10.8
2	534,919	37.7	170,049	12.0	20,502	1.4	17,012	1.2	239,206	16.9
3	304,662	21.5	104,615	7.4	210,296	14.8	50,722	3.6	375,089	26.4
4	237,789	16.8	211,978	14.9	342,153	24.1	39,107	2.8	138,557	9.8
5	143,181	10.1	157,785	11.1	198,888	14.0	10,629	0.7	337,271	23.8

*Highest value is 5.
**Lands or areas that were already developed or were not considered pertinent for the analysis of a particular resource were not assigned a value. For example, water areas were not calculated as part of the total acreage for assessment of biodiversity, farmland, or forest land.



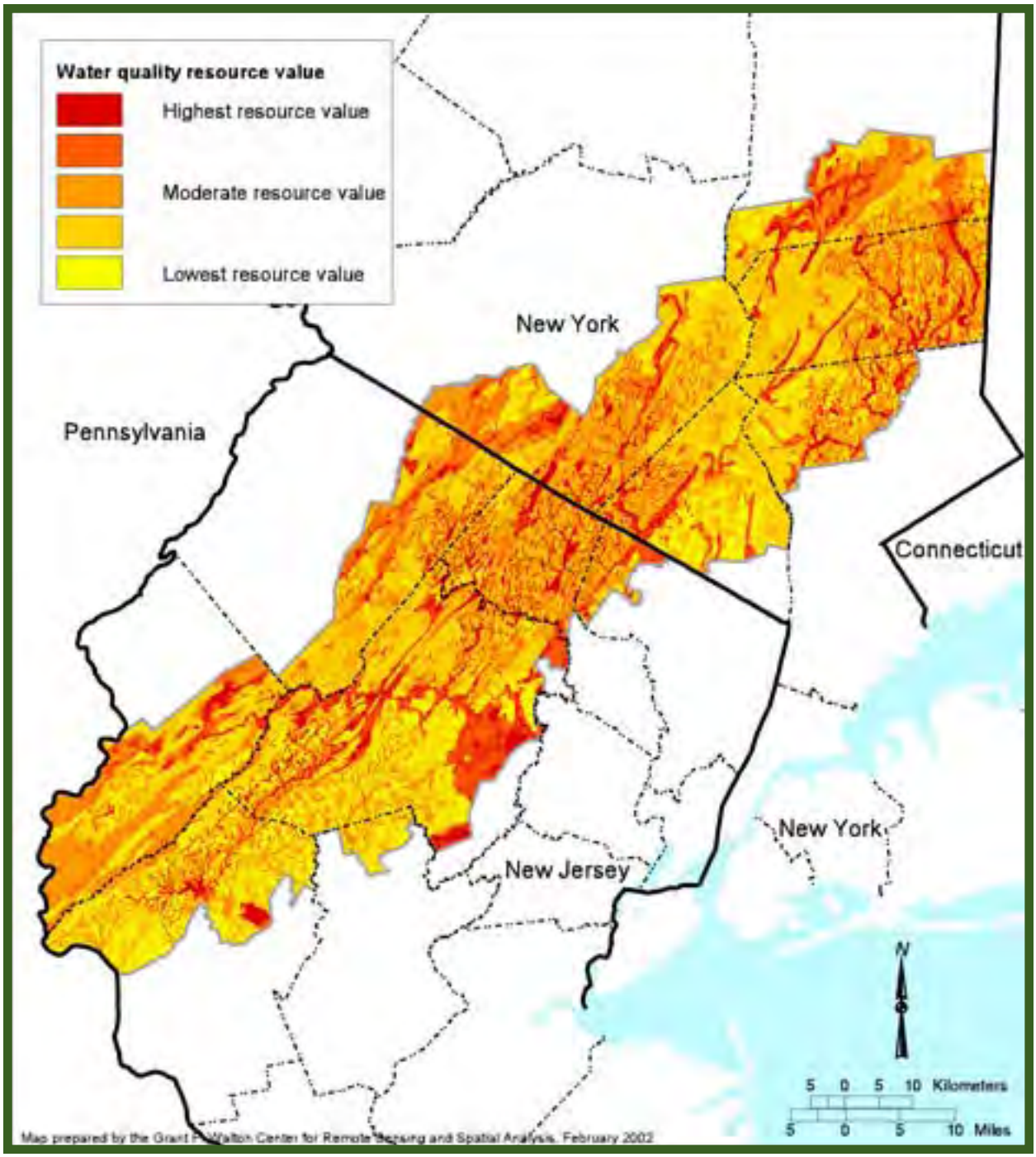


Figure 2-20. Water resource values. Almost half of the Highlands study area has medium to high value for the quality of its water resources, as determined by the Conservation Values Assessment.

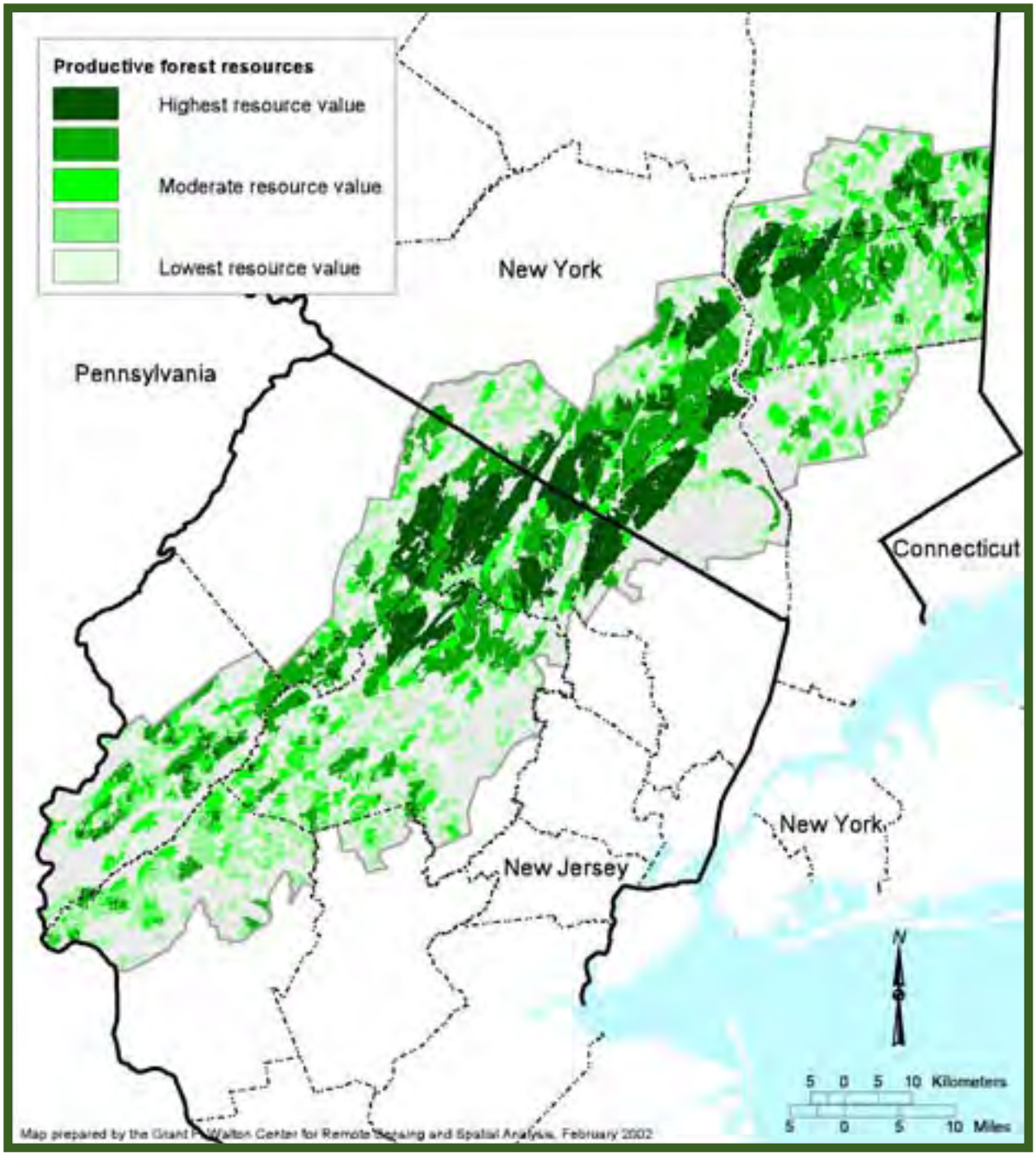
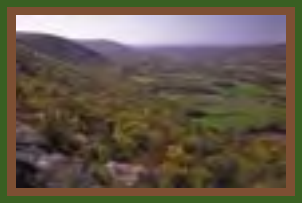


Figure 2-21. Forest resource values. About a third of the Highlands study area has medium to high value for its productive forest resources, as determined by the Conservation Values Assessment.



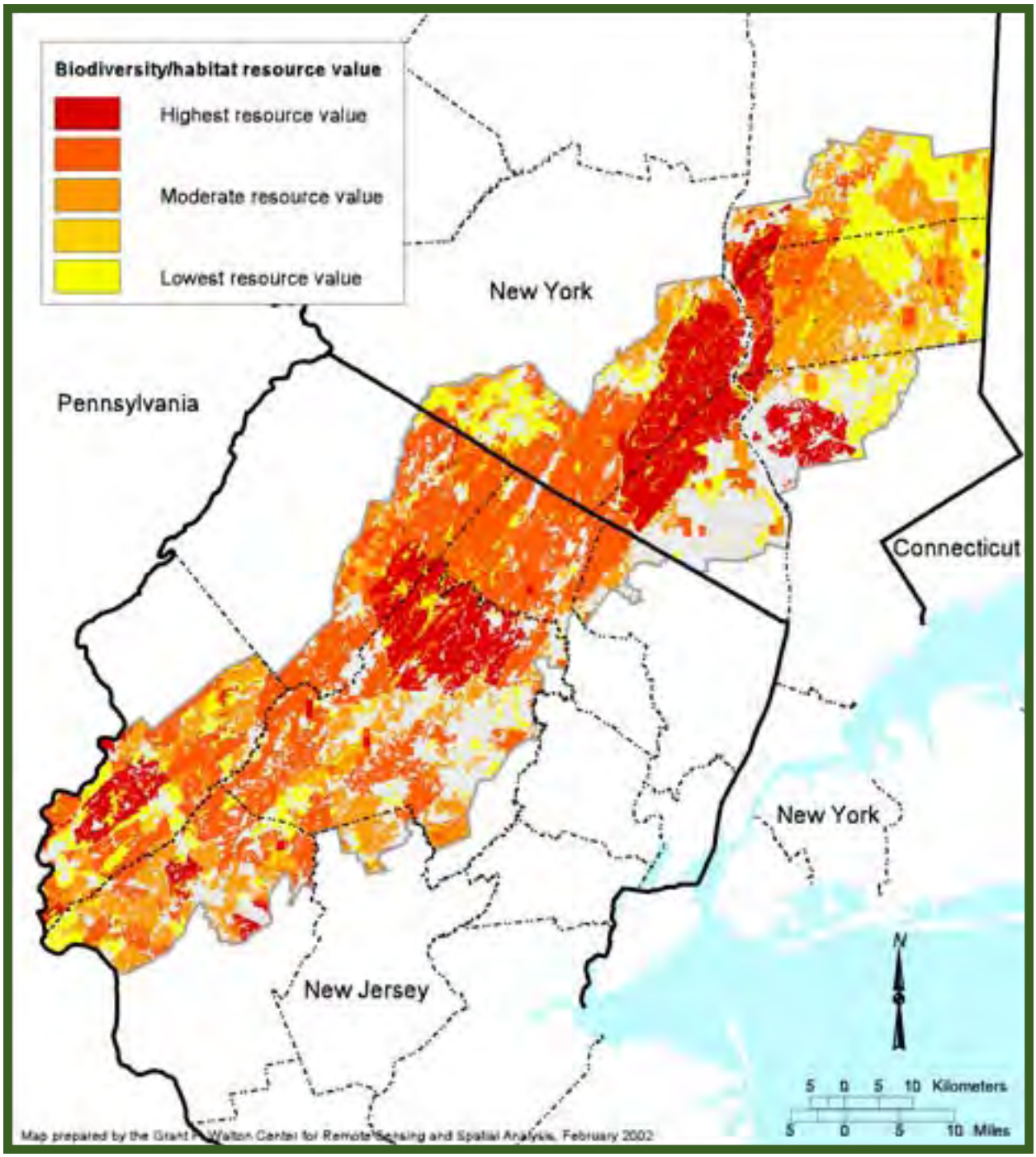


Figure 2-22. Biodiversity resource values. More than half of the Highlands study area is high value habitat that supports State or Federally listed threatened and endangered species, as determined by the Conservation Values Assessment.

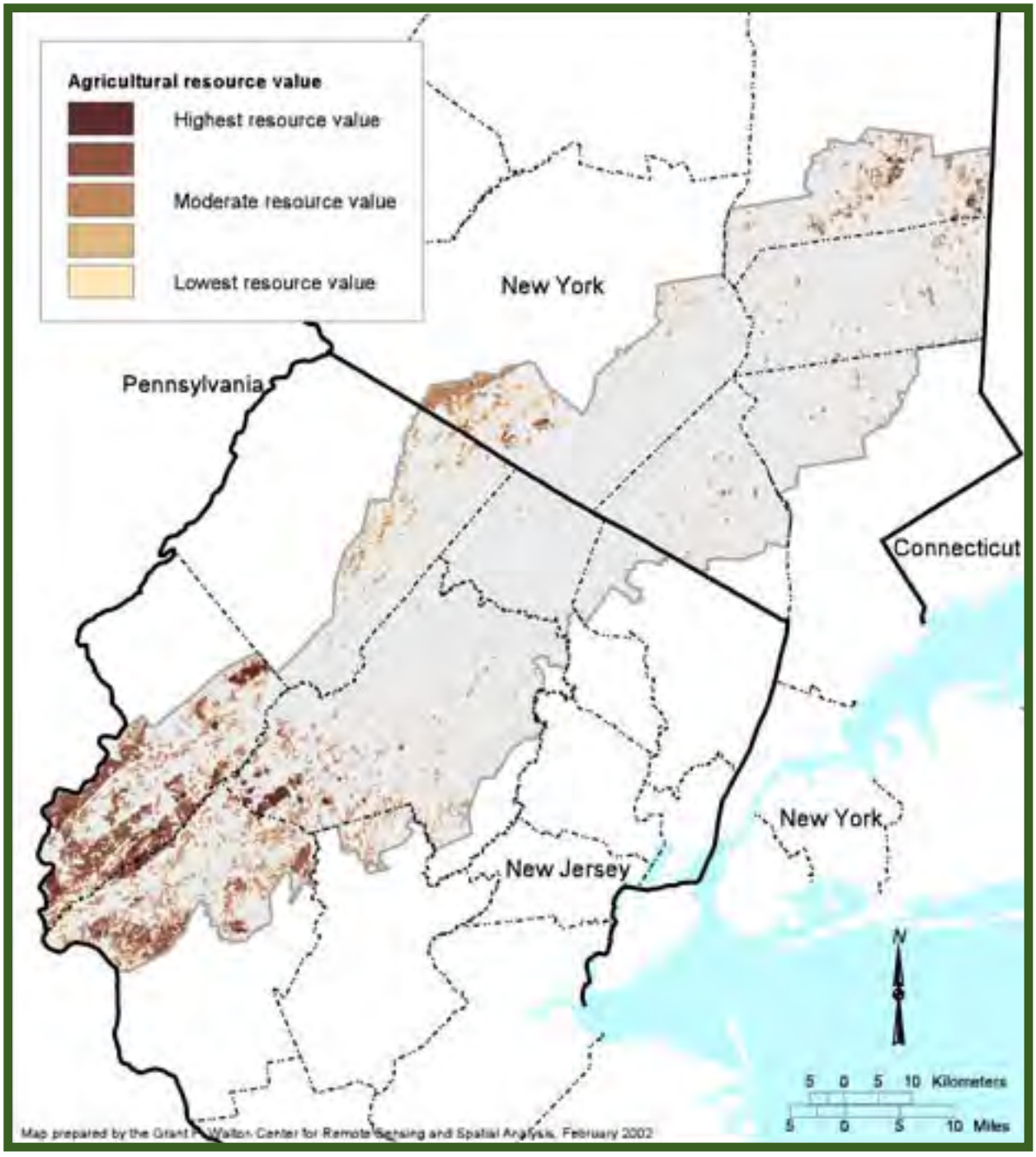


Figure 2-23. Farmland resource values. Over 100,000 acres (7 percent) of the Highlands study area has medium to high value for its productive farmland, as determined by the Conservation Values Assessment.

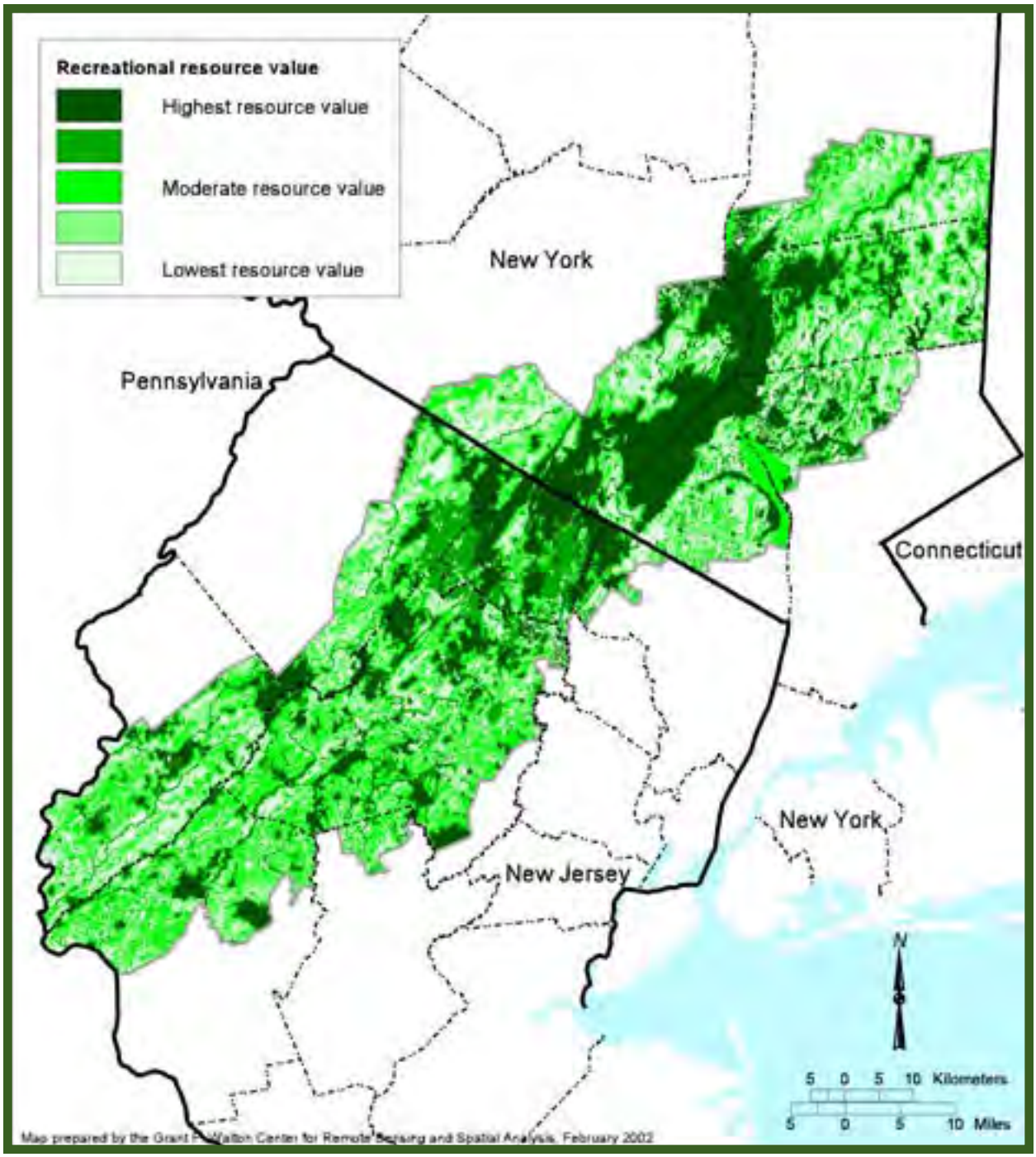
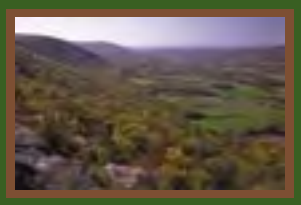


Figure 2-24. Recreation resource values. Sixty percent of the Highlands study area has medium to high value for recreation opportunities, historical and cultural sites, and open space, as determined by the Conservation Values Assessment.



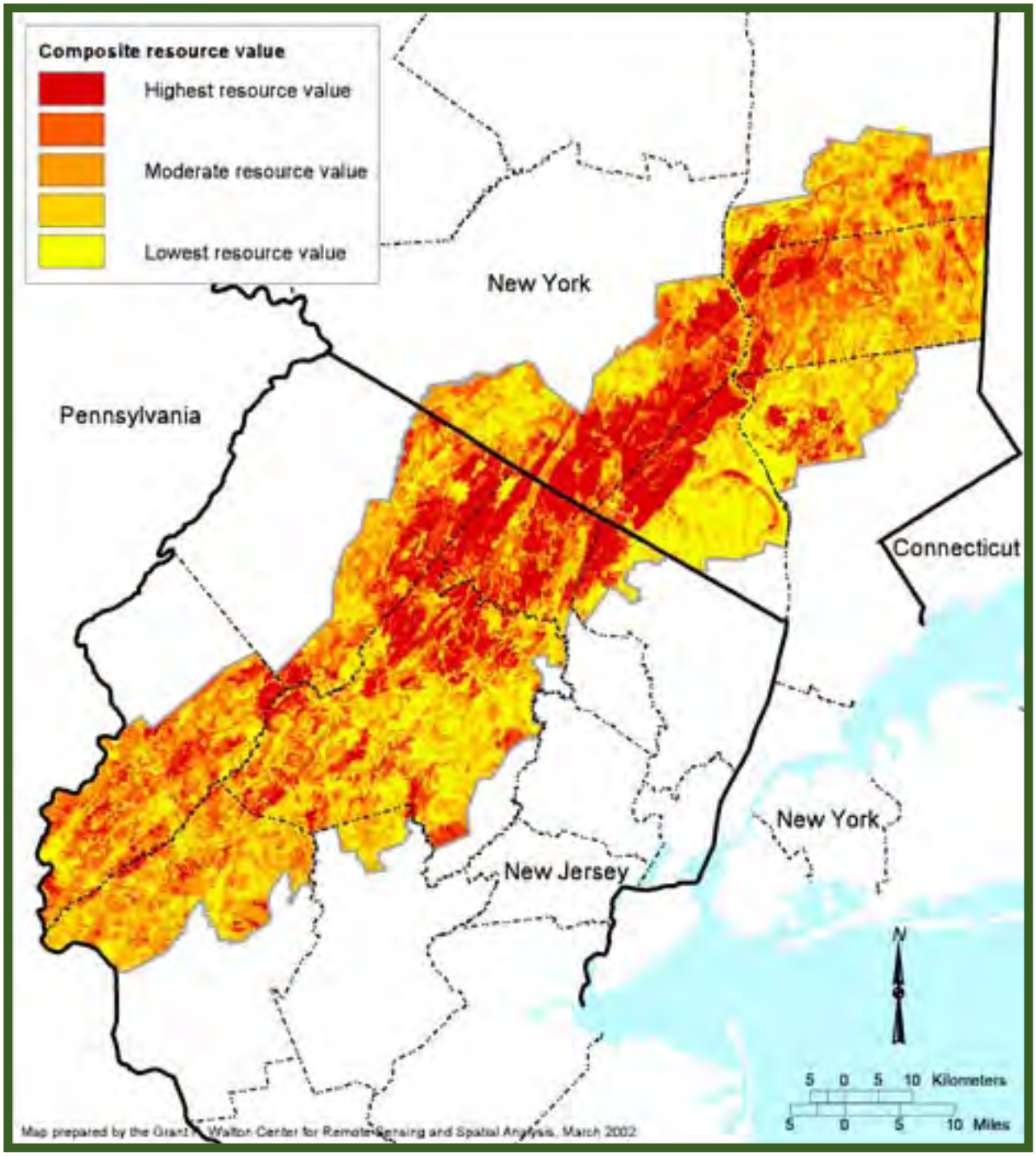
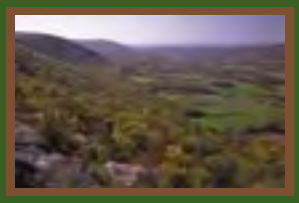


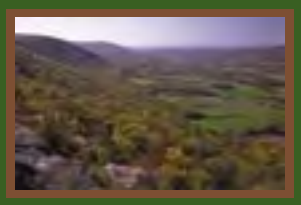
Figure 2-25. Composite conservation values. Over 500,000 acres (38 percent) of the Highlands study area has exceptional conservation value, that is, higher or highest value for all resource types (water, forest, biodiversity, farmland, and recreation), as determined by the Conservation Values Assessment.



CONSERVATION VALUES ASSESSMENT: KEY FINDINGS

KEY FINDINGS:

- **While all of the Highlands serves as watershed land, nearly 50 percent (685,632 acres) has medium to high values deserving special consideration.** A number of factors are important to conserving the quality and quantity of Highlands water, including restricting development and maintaining natural vegetation cover over sensitive aquifers, wellhead protection zones, reservoir catchment areas, steep slopes (greater than 15 percent), and riparian zones.
- **Thirty-three percent (474,378 acres) of the Highlands has medium to high value as productive forest land.** Many of the resources rely on the maintenance of intact productive forest systems. Management of Highlands forests to sustain this resource base for continued production of forest products such as timber, wildlife, water, and recreation is supported through the actions of private landowners and the conservation programs of private nonprofit land trusts and publicly owned forest lands.
- **Nearly 55 percent (748,723 acres) of the Highlands consists of habitat that supports State or Federally listed threatened and endangered species.** The Highlands support a diverse ecological system that is still largely intact and is home to a number of endangered and threatened animal and plant species. Large tracts of contiguous forests and accompanying wetland systems support a number of forest interior dependent species. Large tracts of grassland and farmland in the southern Highlands, as well as tracts interspersed elsewhere across the region, are home to rare grassland nesting birds. The region's large lakes, reservoirs, and rivers also provide critical habitat for a number of species, including our national symbol, the Bald Eagle.
- **Seven percent (100,548 acres) of the Highlands has medium to high value as productive farmland.** While comparatively small in overall area, farmland is still an integral component of the Highlands landscape, especially in the major river valleys of the Delaware, Musconetcong, Pohatcong, Pequest, and Raritan rivers in the south; and the Wallkill and Fishkill rivers in the north.
- **Sixty percent (850,917 acres) of the Highlands has medium to high value for recreation and open space.** As the New York City metropolitan area's backyard, the Highlands supports a variety of outdoor recreational pursuits, scenic landscapes for aesthetic enjoyment, and contains a wealth of important historical and cultural sites. An extensive network of public open space areas provides recreational and cultural experiences to millions of visitors annually.



- **When all resource types were combined, 38 percent (542,456 acres) of the Highlands has exceptional conservation value (ranked Higher or Highest value).** These highest ranked areas include the central core of the Highlands stretching from Green Pond/Mase Mountains in the southwest up through the Pequannock watershed, Sterling Forest, Harriman and Bear Mountain, and then across the Hudson River through the Breakneck Ridge/East Mountain area to the Clarence Fahnestock State Park. There are several notable outlying areas including forested ridges and farmed valleys of the Musconetcong/Scott Mountain area in the southwest, the west end of the New Croton Reservoir in New York, and the Depot Hill/Pawling Mountain area in the northeast.

SECTION 2 REFERENCES

Alerich, C.L.; Drake, D.A. 1995. Forest statistics for New York: 1980 and 1993. Resource Bulletin NE-132. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Research Station; 249 p.

Ayers, M.A.; Kennen, J.G.; Stackelberg, P.E. 2000. Water quality in the Long Island – New Jersey coastal drainages, New York and New Jersey, 1996-98. Circular 1201. Philadelphia, PA: U.S. Geological Survey; 40 p.

Bauersfeld, W.R.; Schopp, R.D. 1991. New Jersey floods and droughts. In National water summary 1988-89, Hydrologic events and floods and droughts. Water-Supply Paper 2375. Philadelphia, PA: U.S. Geological Survey; 401-408.

Birch, T. W. 1996. Private forest landowners of the Northern United States, 1994. Resource Bulletin NE-136. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 293 p.

Bode, Robert W.; Novak, Margaret A.; Abele, Lawrence E. 1993. 20 year trends in water quality of rivers and streams in New York State based on macroinvertebrate data 1972-1992. Albany: New York State Department of Environmental Conservation; 196 p.

dePaul, V.T.; Gardner, P.L.; Kopera, A.J.; Roy, H.C.; Szabo, Z. 2000. Use of ground water radon-222 occurrence data in combination with indoor-air radon potential to maximize benefits of the multimedia radon-mitigation program in New Jersey. [abs] In: National Ground Water Association, Emerging Issues Conference; 2000 June; Minneapolis, MN; 34. (Note: this is a published abstract of a proceedings, no paper is ever intended to be produced or published)

Ellis, W.H., Jr.; Price, C.V. 1995. Development of a 14-digit hydrologic coding scheme and boundary data set for New Jersey. Water Resources Investigations Report 95-4134. Denver, CO: U.S. Geological Survey; 1 sheet.

Griffith, D.M.; Widmann, R.H. 2001. Forest statistics for New Jersey: 1987 and 1999. Resource Bulletin NE-152. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northeastern Research Station; 70 p.

Heath, R.C. 1980. Basic elements of ground-water hydrology with reference to conditions in North Carolina. Water-Resources Investigations Open-File Report 80-44. U.S. Geological Survey; 86 p.

Heath, R.C. 1983. Basic ground-water hydrology. Water Supply Paper 2220. U.S. Geological Survey; 84 p.

Heisig, P. 2000. Effects of residential and agricultural land uses on the chemical quality of baseflow of small streams in the Croton Watershed. Water Resources Investigations Report 99-4173. Denver, CO: U.S. Geological Survey; 16 p.

Hickman, R.E.; Barringer, T.H. 1999. Trends in water quality of New Jersey streams, water years 1986-95. Water Resources Investigations Report 98-4204. Denver, CO: U.S. Geological Survey; 174 p.

Kauffman, L.J., U.S. Geological Survey, written communication, unpublished text on description of watershed model, November 2001.

SECTION 2 REFERENCES

Kennen, J.G. 1999. Relation of benthic macroinvertebrate community impairment to basin characteristics in New Jersey streams. Fact Sheet FS-057-98. Denver, CO: U.S. Geological Survey; 6 p.

La Forge, Laurence. 1905. Water resources of the central and southwestern highlands of New Jersey. In: Contributions to the hydrology of the eastern United States, 1904. Water-Supply Paper 110. Denver, CO: U.S. Geological Survey; 141-155.

Linsey, K.A.; Wolcott, S.W.; Schoonmaker, N.B. 1999. Identification of potential water-resources monitoring sites in the Croton Reservoir System, southeastern New York. Open-file Report 97-638. Troy, NY: U.S. Geological Survey; 36 p.

Michaels, Joseph A.; Neville, L. Robert; Edelman, David; Sullivan, Tim; DiCola, Leslie A. [1992.] New York – New Jersey Highlands Regional Study. [Radnor, PA: USDA Forest Service, Northeastern Area State and Private Forestry]; 130 p.

National Agricultural Statistics Service. 1999. 1997 Census of agriculture: New Jersey state and county data. Volume 1, Geographic Area Series Part 30. Washington, DC; 530 p.

National Audubon Society. 2001. [Partners in Flight] http:www.Audubon.org/bird/watch (23 August 2002).

New Jersey Department of Environmental Protection. 1998. Surface water quality standards. Trenton: Office of Environmental Planning; 122 p.

New Jersey Department of Environmental Protection, Bureau of Freshwater Biological Monitoring. 2001. NJDEP Ambient Biomonitoring Network (AMNET). 2000. [Digital data]. http://www.state.nj.us/dep/gis/digidownload/zips/statewide/biopts2k (19 February 2002).

New Jersey Department of Environmental Protection and Energy. 1992. New Jersey Statewide water supply master plan Task 2 report: Water supply baseline data development and analyses. Trenton, NJ; 200 p.

New Jersey Department of Environmental Protection Green Acres Program. 1999a. New Jersey's common ground: 1994-1999 New Jersey open space and outdoor recreation plan summary. Trenton: New Jersey Department of Environmental Protection; 34 p.

New Jersey Department of Environmental Protection Green Acres Program. 1999b. Meeting the challenge: Preserving one million more acres of New Jersey's open space. Trenton: New Jersey Department of Environmental Protection; 15 p.

New Jersey Water Supply Authority. 2000. Water supply availability in the Raritan River Basin. A technical report for the Raritan Basin watershed management project; 23 p. http://www.raritanbasin.org/technical_reports.htm (8 August 2002).

New York Agricultural Statistics Service. 2001. New York agricultural statistics: 2000-2001. Albany, NY; 101 p.

New York City Department of Environmental Protection. 2002. New York City's water supply system. http://www.nyc.gov/html/dep/html/maplevels.html. [Date accessed unknown].

Regional Plan Association. 2001. NY/NJ Highlands Priority Area Assessment. Unpublished paper supplied by the association; 12 p.

SECTION 2 REFERENCES

Rosenshein, Joseph S. 1988. Region 18, Alluvial valleys. In: Back, William; Rosenshein, Joseph S.; Seaber, Paul R., eds. Hydrogeology. Geology of North America, vol. O-2. Boulder, CO: Geological Society of America; 165-175.

Royle, D.D. 2002. A landscape analysis of hemlock decline in New Jersey. New Brunswick, NJ: Rutgers University, Unpublished PhD thesis.

U.S. Environmental Protection Agency. 1999. Overall watershed characterization: September 1999. IWI Release (Note: IWI stands for Index of Watershed Indicators). http://www.epa.gov/iwi/1999sept/catalog.html (28 February 2002).

Vermeule, C.C. 1894. Water supply. Geological Survey of New Jersey, vol. 3. Trenton, NJ; 352 p.

Zimmerman, P. 2001. Sustainable design at New York City Department of Environmental Protection. Clearwaters 31(3). http://www.nywea.org/313090.html (14 February 2002).

Section 3 Potential Changes and Resources at Risk

Photograph by George M. Aronson

"The Nation does well if it treats natural resources as assets which it must turn over to the next generation increased and not impaired in value."

President Theodore Roosevelt

SECTION 3 POTENTIAL CHANGES AND RESOURCES AT RISK

This section uses past population growth to model future population growth and development in the Highlands, to determine how they could affect natural resources. By looking at these possible changes, the resource conservation values from Section 2, and land that is already protected, this section identifies land in the Highlands that is most in need of conservation. All population numbers, density, and growth, and demographic and housing trends in this section are from the U.S. Census Bureau (2001).

POPULATION GROWTH

The 2000 census found that the 108 municipalities in the New York and New Jersey portions of the Highlands have approximately 1,372,000 residents. Of that number, 46 percent live in New York and 54 percent in New Jersey. When compared with the 1990 figure of about 1,230,000 people, the region's population has grown by more than 11 percent (Table 3-1). The overall population density

Table 3-1. Population change in the Highlands, 1990-2000 (based on 2000 census data)

	Population		
Region	**1990**	**2000**	**Percent change**
New Jersey Highlands	665,257	743,680	+11.8
New York Highlands	565,067	628,743	+11.3
Total	**1,230,324**	**1,372,423**	**+11.5**

for the entire region was just below one person per acre (Figure 3-1). The region currently averages 2.76 persons per household. New York's Highlands have a slightly higher average of 2.9 compared with New Jersey's average of 2.6. The nine most densely populated municipalities in 2000 were these:

Municipality	Persons per acre
Pompton Lakes borough (New Jersey)	5.27
Washington borough (New Jersey)	5.36
Boonton town (New Jersey)	5.38
Butler borough (New Jersey)	5.54
Peekskill city (New York)	6.41
Phillipsburg town (New York)	7.10
Morristown town (New Jersey)	9.65
Dover town (New Jersey)	10.52
Victory Gardens borough (New Jersey)	16.55

The region's 10-year growth rate of 11 percent is lower than that of the United States (13 percent) but higher than that of either State (New Jersey grew 8.9 percent, while New York grew 5.5 percent). The fastest growing municipality in the New York – New Jersey Highlands, Greenwich Township, was also the fastest growing in New Jersey. Greenwich was the only municipality in the region to double its size between 1990 and 2000, with a population increase of 130 percent. Greenwich's rapid growth is due, in part, to having a small population in a relatively large area, so that a few new subdivisions caused a significant population increase. The next fastest growing municipalities were these:

Municipality	Growth rate (percent)
Mahwah Township, NJ	34
Montville Township, NJ	34
Chester Borough, NJ	35
Monroe Town, NY	36
Independence Township, NJ	42

A total of 21 municipalities had more than a 20 percent growth in population.

New Jersey also had the only two municipalities that lost more than 10 percent of their population during that period: Netcong Borough (22 percent loss) and Harding Township (13 percent loss). A total of 13 municipalities in the Highlands lost population. The growth and loss of population by municipality is shown in Figure 3-2.

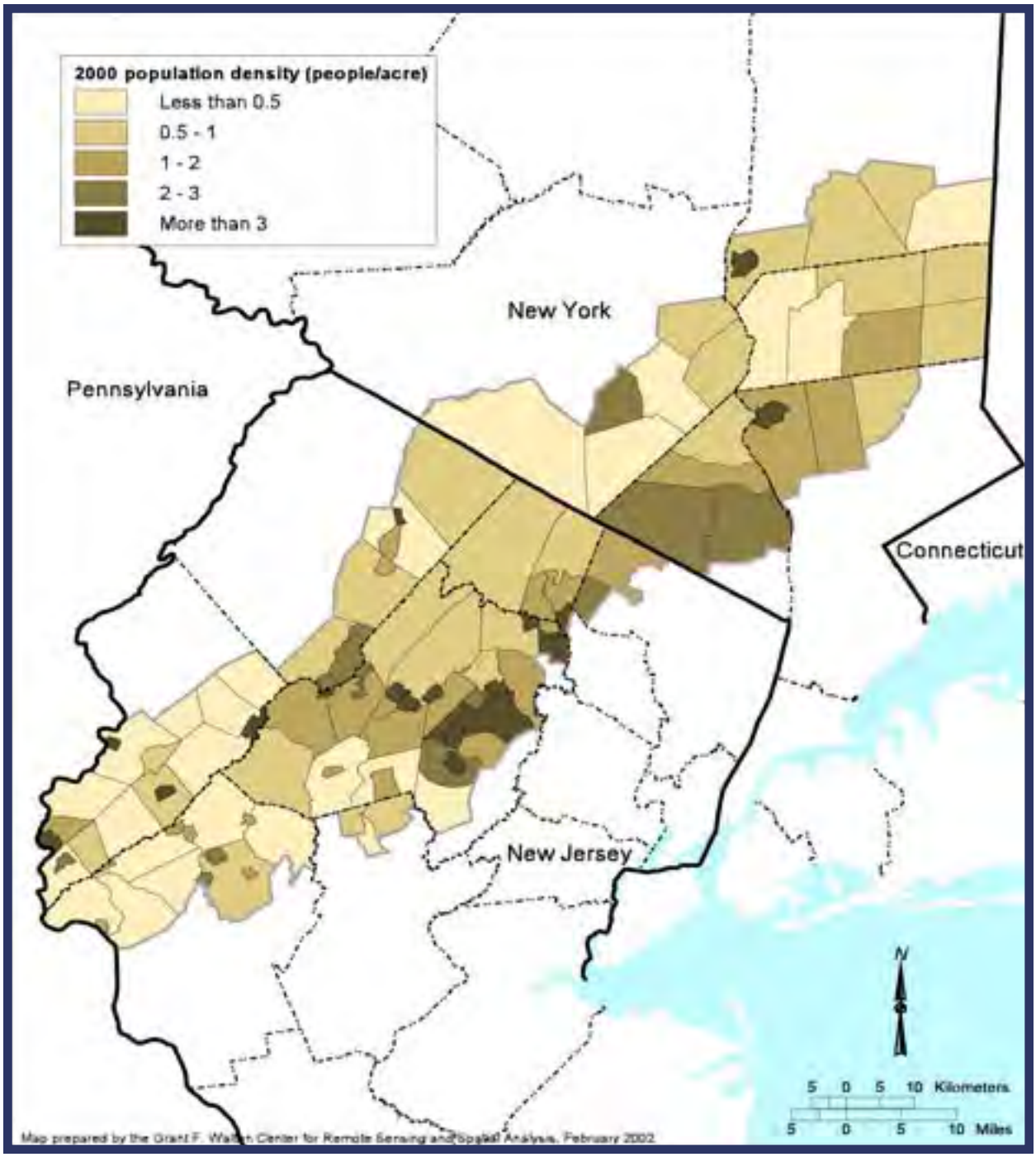


Figure 3-1. Population density in municipalities. The population density in the Highlands was about 1 person per acre in 2000. This map shows population density by municipality.

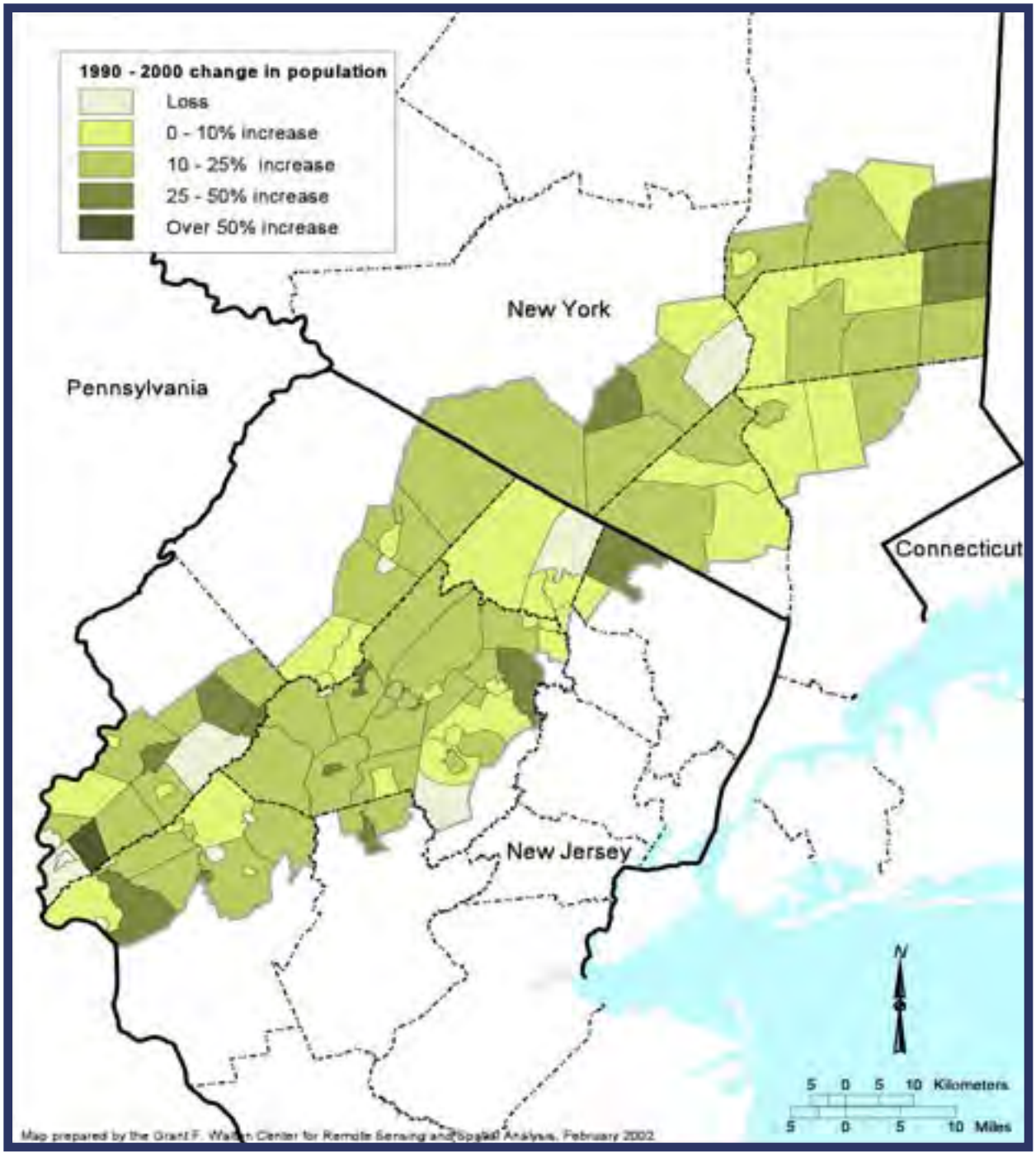


Figure 3-2. Change in municipality populations. The population change in the Highlands by municipality shows that 21 municipalities grew by more than 20 percent and 13 municipalities lost population, from 1990 to 2000.

POPULATION GROWTH

For the 108 municipalities included in the study, the average population was 12,708 while the median population was 7,471. Only three municipalities had more than 50,000 residents as shown in the following list of the nine largest municipalities:

Municipality	2000 Population
Warwick town (New York)	30,764
Monroe town (New York)	31,407
Carmel town (New York)	33,006
Haverstraw town (New York)	33,811
Yorktown town (New York)	36,318
Cortlandt town (New York)	38,467
Parsippany-Troy Hills township (New Jersey)	50,649
Clarkstown town (New York)	82,082
Ramapo town (New York)	108,905

The smallest municipality had less than 1,000 residents:

Municipality	2000 Population
Far Hills borough (New Jersey)	859
Bloomsbury borough (New Jersey)	886
Califon borough (New Jersey)	1,055
Lebanon borough (New Jersey)	1,065
Milford borough (New Jersey)	1,195

Due to the limited availability of the 2000 census data, some analyses were conducted at a county scale and, therefore, include data for the entire 12-county area (not just for the 108 municipalities formally regarded as the Highlands in the rest of this report). The Highlands region's population is representative of the overall populations of the larger New York and New Jersey State region in terms of gender ratio, population under 15 years of age, and population over 65 years of age (Table 3-2). Likewise, these figures have not changed significantly since 1990. The median age of the population in 2000 varied significantly across the various counties, ranging from 34.7 to 39.1 years, but was similar to the median age for New York and New Jersey (Table 3-2).

The Highlands counties have a less racially diverse population than that of the larger New York and New Jersey region. In 2000 the Highlands counties were 78.5 percent white, while the State of New York was 67.9 percent white and the State of New Jersey was 72.6 percent white (Table 3-2). There is great variability in racial diversity across the Highlands region. Counties with major urban centers with large minority and recent immigrant populations, such as Passaic County in New Jersey, which is 62.3 percent white, have more racially diverse populations than many of the more rural counties that are more than 90 percent white.

Occupied housing, at 96.1 percent, was slightly higher in the Highlands counties than in the larger New York and New Jersey region in 2000 (Table 3-3). There was a slight increase in the percent of occupied housing from 1990 to 2000. Owner-occupied housing was 67.9 percent versus 32.1 percent renter-occupied in 2000. The New York Highlands counties have a somewhat lower owner occupancy (65.2 percent) than New Jersey (69.9 percent). From 1990 to 2000 in New Jersey the more urban counties, such as Bergen and Passaic, showed a slight decrease in owner-occupied housing, while the more rural counties such as Hunterdon and Warren showed an increase. The various counties in New York showed no significant pattern over the decade.

Key Findings:

- According to the 2000 census, **the population of the Highlands region grew 11.5 percent** between 1990 and 2000 to a total of 1,372,423 residents.
- **A total of 21 municipalities in the Highlands grew more than 20 percent** between 1990 and 2000. Greenwich Township was the fastest growing municipality, doubling its population between 1990 and 2000, according to the 2000 census.
- **A total of 13 municipalities** in the Highlands **lost population** between 1990 and 2000.
- **Ramapo, New York was the largest municipality** with 108,905 residents. Far Hills, New Jersey was the smallest municipality with less than 1,000 residents.
- The Highlands counties' **population was representative of the overall population** of the larger New York and New Jersey State region based on gender ratios and age breakdowns in 2000.
- **The Highlands counties had a less racially diverse population** than that of the New York and New Jersey State region in 2000.
- **The percent of occupied housing, at 96.1 percent, was slightly higher in the Highlands counties** than in the States of New York and New Jersey in 2000.

POPULATION GROWTH

Table 3-2. Demographic trends in the Highlands, 1990-2000

State and County	Total population 2000	Total population 1990	Total population Percent change	Percent males 2000	Percent males 1990	Percent males Percent change	Percent under 15* 2000	Percent under 18* 1990	Percent over 65 2000	Percent over 65 1990	Percent over 65 Percent change	Median age 2000**	Median age 1990	Percent white 2000	Percent white 1990	Percent white Percent change
New Jersey																
Bergen	884,118	825,380	7.1	48.1	48.0	0.1	19.3	20.4	15.2	15.3	-0.1	39.1	N/A	78.4	87.0	-8.6
Hunterdon	121,989	107,776	13.2	49.4	49.9	-0.5	21.8	24.1	10.0	9.5	0.6	38.8	N/A	93.9	96.3	-2.4
Morris	470,212	421,353	11.6	48.9	48.8	0.1	21.2	22.9	11.6	10.5	1.1	37.8	N/A	87.2	91.8	-4.6
Passaic	489,049	453,060	7.9	48.5	48.2	0.3	22.1	24.0	12.1	12.9	-0.8	34.8	N/A	62.3	71.9	-9.5
Somerset	297,490	240,279	23.8	48.8	49.1	-0.3	22.0	22.0	11.2	10.8	0.4	37.2	N/A	79.3	88.0	-8.6
Sussex	144,166	130,943	10.1	49.5	49.6	-0.1	23.4	27.8	9.1	8.9	0.2	37.1	N/A	95.7	97.6	-1.9
Warren	102,437	91,607	11.8	48.7	48.3	0.4	21.9	24.7	12.9	13.3	-0.4	37.6	N/A	94.5	97.2	-2.6
Total***	2,509,461	2,270,398	10.5	48.6	48.5	0.1	21.0	22.5	12.8	12.7	0.0	N/A	N/A	79.4	86.4	-7.0
New York																
Dutchess	280,150	259,462	8.0	50.0	50.3	-0.3	20.9	23.9	12.0	11.4	0.6	36.7	N/A	83.7	88.3	-4.7
Orange	341,367	307,647	11.0	50.1	50.3	-0.2	24.4	27.6	10.3	10.4	-0.1	34.7	N/A	83.7	88.9	-5.2
Putnam	95,745	83,941	14.1	49.9	49.9	0.0	22.3	25.8	9.6	9.0	0.5	37.4	N/A	93.9	97.5	-3.6
Rockland	286,753	265,475	8.0	48.8	48.6	0.2	23.5	26.0	11.8	10.1	1.7	36.2	N/A	76.9	83.9	-7.0
Westchester	923,459	874,866	5.6	47.8	47.5	0.4	21.2	21.7	14.0	14.4	-0.4	37.6	N/A	71.3	79.4	-8.0
Total***	1,927,474	1,791,391	7.6	48.8	48.6	0.2	22.1	23.9	12.5	12.4	0.1	N/A	N/A	77.3	83.8	-6.6
Highlands county total	4,436,935	4,061,789	9.2	48.7	48.6	0.1	21.5	23.1	12.6	12.6	0.1	N/A	N/A	78.5	85.3	-6.8
New Jersey (Statewide)	8,414,350	7,730,188	8.9	48.5	48.3	0.2	20.9	23.3	13.2	13.4	-0.1	36.7	34.4	72.6	79.3	-6.8
New York (Statewide)	18,976,457	17,990,455	5.5	48.2	47.9	0.3	20.7	23.7	12.9	13.1	-0.2	35.9	33.9	67.9	74.4	-6.5

Source: U.S. Census Bureau (2001)

*U.S. Census thresholds for the youngest age category changed from "Under 18" in 1990 to "Under 15" in 2000.
**The U.S. Census Bureau did not have information on median age available by county in 1990.
***The New Jersey county total and New York county total represent only those counties that include some portion of the Highlands. These county numbers include the entire county, including areas beyond the Highlands boundary.

Table 3-3. Housing trends in the Highlands, 1990-2000

State and County	Housing units			Percent occupied			Percent owner occupied		
	2000	1990	Percent change	2000	1990	Percent change	2000	1990	Percent change
New Jersey									
Bergen	339,820	324,817	4.6	97.4	95.1	2.3	67.2	67.9	-0.8
Hunterdon	45,032	39,987	12.6	97.0	94.8	2.2	83.6	80.5	3.1
Morris	174,379	155,745	12.0	97.3	95.5	1.8	76.0	74.0	2.0
Passaic	170,048	162,512	4.6	96.4	95.5	0.8	55.6	55.8	-0.2
Somerset	112,023	92,653	20.9	97.3	95.4	1.9	77.2	75.3	1.9
Sussex	56,528	51,574	9.6	89.9	86.2	3.7	82.7	82.3	0.4
Warren	41,157	36,589	12.5	93.9	92.9	1.0	72.7	69.5	3.2
Total*	938,987	863,877	8.7	96.5	94.6	1.9	69.9	69.0	0.9
New York									
Dutchess	106,103	97,632	8.7	93.8	91.7	2.1	69.0	69.1	-0.2
Orange	122,754	110,814	10.8	93.5	91.6	1.9	67.0	67.5	-0.4
Putnam	35,030	31,898	9.8	93.4	88.1	5.3	82.2	81.9	0.4
Rockland	94,973	88,264	7.6	97.6	96.2	1.4	71.7	72.1	-0.5
Westchester	349,445	336,727	3.8	96.5	95.0	1.4	60.1	59.7	0.5
Total*	708,305	665,335	6.5	95.6	93.8	1.8	65.2	65.0	0.3
Highlands county total	1,647,292	1,529,212	7.7	96.1	94.3	1.8	67.9	67.2	0.6
New Jersey (Statewide)	3,310,275	3,075,310	7.6	92.6	90.9	1.7	65.6	64.9	0.7
New York (Statewide)	7,679,307	7,226,891	6.3	91.9	91.9	0.0	53.0	52.2	0.8

Source: U.S. Census Bureau (2001)

*The New Jersey county total and New York county total represent only those counties that include some portion of the Highlands. These county numbers include the entire county, including areas beyond the Highlands boundary.

FUTURE CHANGE SCENARIOS—BUILD-OUT ANALYSIS AND ECONOMETRIC MODELING

One of the major trends in the Highlands is the increasing amount of development and the number of people who live there. Since this study is meant to assist with decisions about the future of land resource changes in the New York – New Jersey Highlands, it needs to first consider some possible future changes in the human population and the associated changes in developed areas.

We used two techniques to assess ways in which the landscape might change in the future: build-out analysis and econometric modeling. We chose these techniques for different purposes. Neither technique actually forecasts future change or predicts whether individual properties will be developed, but both techniques illustrate potential consequences of policy and market forces.

A simple way to consider future change would be to simply answer the question, "How much could be built today under the existing zoning and environmental constraints?" Basically, that is the question that build-out analysis seeks to answer. The analysis was expanded to include a few different future policy scenarios to demonstrate different future population distributions.

For the area being analyzed, the process begins by removing from consideration places that would not realistically be developed in the future. These areas might include lands that are rendered unbuildable due to natural features, areas in which an existing policy prohibits development, urban areas already developed to their fullest legal extent, and permanently protected properties (including public lands). The remaining areas are analyzed to find out how many houses could be built on them under the current zoning regulations, with some recognition of additional infrastructure needs.

Many different factors impact whether land is developed. In many areas, lands closer to existing built areas are more likely to be developed. Planners often assume that sewered areas are more likely to develop than other areas. Since the Highlands is a unique region, these broad assumptions were not seen as entirely reliable. Therefore, an econometric analysis was done to determine which factors were most important in driving change between 1995 and 2000, and—by reapplying them—to identify areas more likely to change in the future. An econometric model considers the many different factors that might impact property values that lead to decisions about whether to develop properties. The model assumes that past development has been a reflection of market forces, and that future change will be determined by those same forces.

The econometric analysis looks at two past moments in time (for example, Year A and Year B) and compares the change between the two. It also looks at many different known conditions in Year A, such as whether places are near urban areas or whether they are in sewered areas. The analysis then examines whether

any conditions were more closely related to the points that changed between Year A and B than they were related to the conditions that did not change. Finally, a statistical process helps to discard irrelevant conditions and provides measures of impact for the remaining factors. This final product of the analysis can be applied to the current factors as a measure of the likelihood of future change. While this analysis is informed by economic theory, it should not be confused with an economic analysis of the region.

Build-Out Analysis

The build-out analysis for the Highlands first removed from consideration places where population would not change. In order to show potential patterns of varying impacts, two different scenarios were constructed:

- Low-constraint scenario of areas that presumably would develop if existing policies (including zoning) were continued unchanged indefinitely (Figure 3-3), and
- High-constraint scenario of areas that presumably would develop if some policies (excluding zoning) were changed to increase the constraints on future development (Figure 3-4).

For both scenarios, areas that are already built as densely as allowed by current zoning were removed from consideration. Commercially and industrially zoned areas were also removed as places for future population change.

A map of areas where population could change was developed. These areas were then analyzed to compare the number of households allowed by zoning and the number of persons that might live in each household. In areas where new development was calculated, 20 percent of the area was removed to account for future infrastructure necessary to support the new development. The final numbers were summarized to describe the ultimate population that could inhabit the area.

Limitations of Build-Out Analysis

Although zoning and associated policies will certainly change in the future, the build-out analysis of the Highlands provides a meaningful measure of the capacity of an area under an assumed set of constraints. To understand the results of the analysis, it is important to recognize some of the limitations, including problems related to:

- The temporal nature of the data assumptions;
- Generalized zoning data; and
- The scale of analysis.

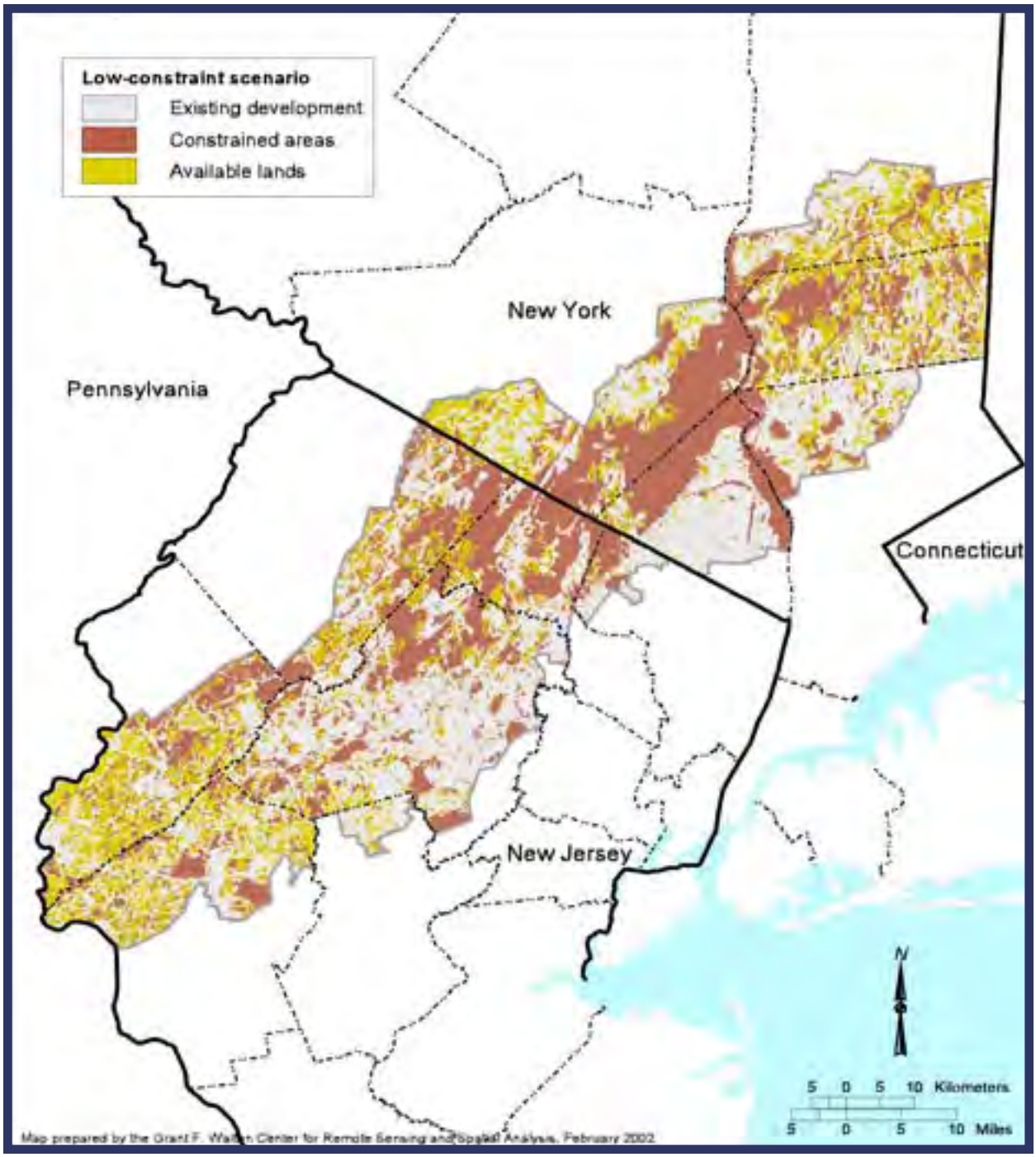
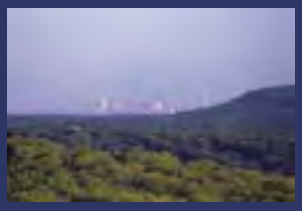


Figure 3-3. Available land for development, low-constraint scenario. The low-constraint scenario of the build-out analysis shows lands that presumably would be available for development, if existing policies—including zoning—continued unchanged indefinitely.



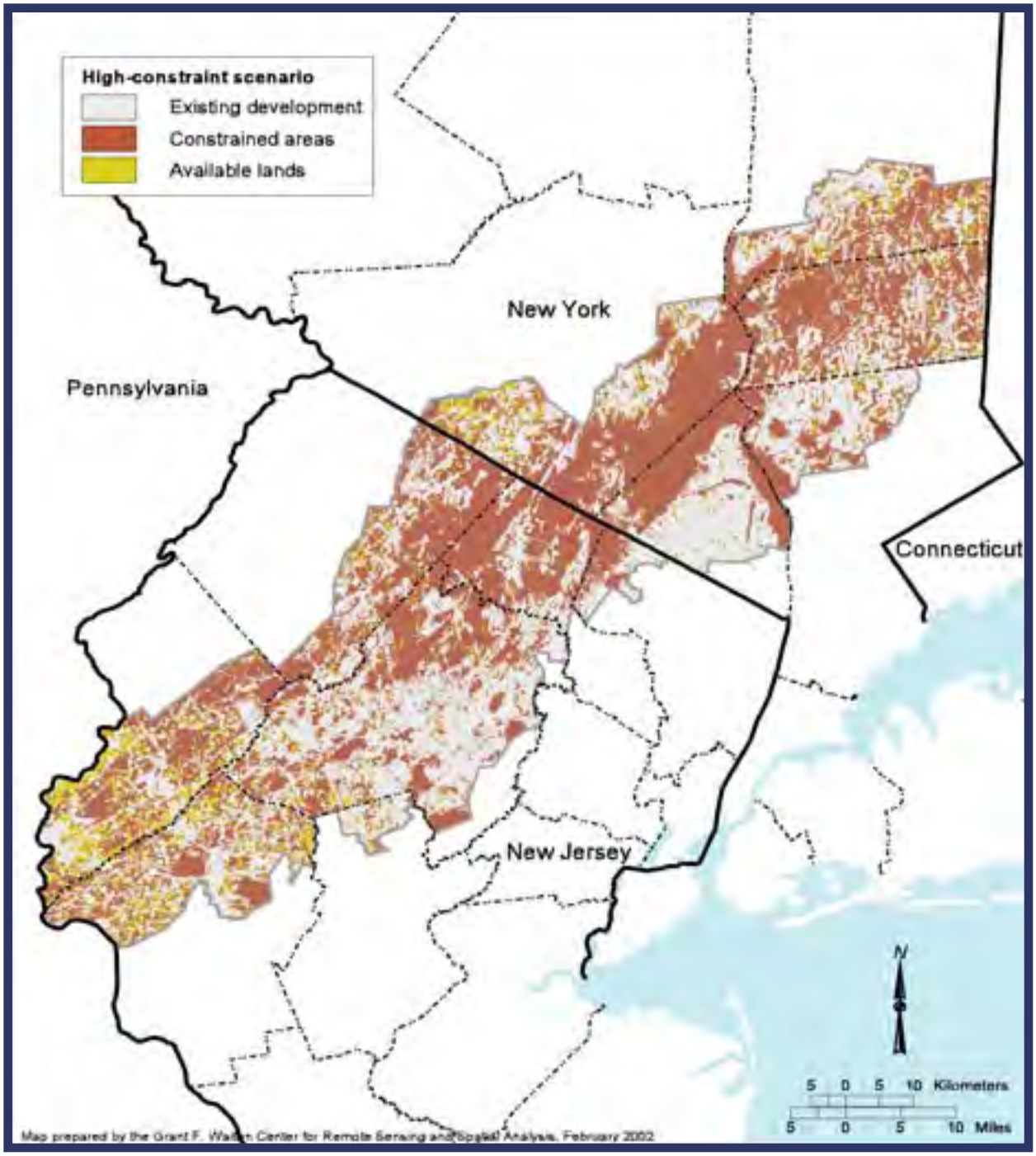


Figure 3-4. Available land for development, high-constraint scenario. The high-constraint scenario of the build-out analysis shows lands that presumably would be available for development, if some policies—excluding zoning—were changed to limit future development.

One of the basic problems with this type of analysis is that it relies heavily on current zoning data. Each of the 108 municipalities in the Highlands has the opportunity to change zoning for individual properties each month. Almost as quickly as a zoning map can be compiled, it begins to fade in its ability to reflect the zoning of the region. While some of the zoning adjustments are insignificant, a municipality could adopt a new plan for a new town center or apartment complexes that will lead to dramatic increases in population. This change would not be reflected in the build-out analysis and would result in an underestimate of future population. Also, additional properties will inevitably be bought or protected as open space, reducing the final built area and population numbers as compared with the build-out analysis. More dramatic policies and projects that were not included in this analysis such as new highways, environmental regulations, and land acquisition can all work to change the future of the Highlands.

A build-out analysis is based on a series of assumptions that are fairly limiting. Aside from the temporal assumption described previously, a build-out analysis assumes that all buildable properties will be built to their fullest capacity and that the houses built will hold the area's average number of people per household. These assumptions may reflect large regional trends but can be problematic in areas with unusual patterns of change, such as a sudden shift to two-person households, i.e., "empty nesters."

In order to analyze the entire region, the zoning ordinances from more than 100 different municipalities were generalized to make them comparable. Local variations and distinctions in the zoning ordinances get lost in this sort of analysis. The build-out analysis for the Highlands was conducted with an awareness of these issues in an attempt to minimize their impact, but many subtleties and complex mechanisms suffered from this necessary generalization.

Finally, because the build-out analysis for the Highlands was conducted at a large regional scale, it was impossible to include some of the careful intertwining of development and constrained areas. For example, a 100-acre parcel with 50 acres of wetlands and wetlands buffer might sometimes be carefully subdivided into 5-acre lots in a spatial arrangement that still achieves the maximum 20 houses, without infringing upon the wetlands. The build-out analysis would calculate the area as having room for only ten 5-acre lots.

CRITERIA FOR THE LOW-CONSTRAINT SCENARIO

The intent of the low-constraint scenario was to map those areas that presumably would develop if existing policies remain unchanged indefinitely. The following areas were excluded from this scenario:

- Known public lands and protected lands (this includes State parks, local parks, Federal properties, and known conservation easements);
- Open water with 50-foot distance buffers;
- Wetlands with 50-foot distance buffers;
- Slopes over 33 percent;
- Areas zoned for nonresidential use; and
- Residential areas already built to their zoning capacity.

The known public lands included only those water supply lands that were known to the study team to be permanently protected lands. For example, portions of the Newark water supply areas that are not protected by New Jersey's Green Acres Program (Appendix I) were considered eligible for development under the low-constraint scenario. For this scenario, wetlands were delineated based on the existing maps from the New York State Department of Environmental Conservation and the New Jersey Department of Environmental Protection delineation of regulated fresh water wetlands.

These constraints are based on a series of assumptions designed to reflect realistic patterns of future development. The 33 percent limitation on slope does not reflect existing zoning limitations in most places, but is meant to approximate a significant reduction of housing density on particularly steep slopes. The distance buffers do not generally reflect existing policies, but reflect that a limited amount of housing would be built directly on streambanks and edges of wetland areas.

CRITERIA FOR THE HIGH-CONSTRAINT SCENARIO

The intent of the high-constraint scenario was to map those areas that presumably would develop if current policies and conditions were modified to provide additional environmental protections. The following areas were excluded from this scenario:

- Known public lands and protected lands (this includes State parks, local parks, Federal properties, known conservation easements, and all water supply lands);
- Open water with 200-foot distance buffers;
- Wetlands with 150-foot distance buffers;
- Slopes over 15 percent;
- Areas zoned for nonresidential use; and
- Residential areas already built to their zoning capacity.

The known public lands included all water supply lands as permanently protected lands. The wetlands for the high-constraint map differed for each State. For New Jersey, the Department of Environmental Protection's delineation of wetlands was combined with the National Wetlands Inventory. For New York, Department of Environmental Conservation data were combined with the National Wetlands Inventory (U.S. Fish and Wildlife Service 2000).

FUTURE CHANGE SCENARIOS: BUILD-OUT ANALYSIS

Potential future constraints are difficult to determine, but the existing constraints were expanded based on patterns in other areas. The buffers used reflect some of the more restrictive buffers in forestry and planning regulations. The 15 percent limitation on slope reflects some of the more recent zoning ordinances in the greater New York – New Jersey region. These constraints help to compensate for other future constraints that are not plausible to include, such as private deed-restricted properties, sewer-related limitations, and future zoning changes.

RESULTS OF THE BUILD-OUT ANALYSIS

Comparison of the low-constraint population density (Figure 3-5) with the high-constraint population density (Figure 3-6) illustrates significant differences. The low-constraint scenario, perhaps a more realistic reflection of the current regulatory limitations, showed a population increase of 47.6 percent (Figure 3-7, Table 3-4). Under the high-constraint model, the population for the Highlands as a whole could increase by about 26.3 percent (Figure 3-8). Under both scenarios, rates of growth would be similar.

While the build-out analysis is a temporal measure of potential change, it can offer a glimpse of the existing problem. Under the assumptions of the build-out scenarios and the assumption that the Highlands population continues to grow at the same rate as it did between 1990 and 2000 (an average annual rate of about 1.1 percent), build-out would be reached by the next generation; however, these assumptions do not reflect the more complex growth patterns that would surely occur. Under the high-constraint scenario, build-out would be reached in 2021, and under the low-constraint scenario, build-out would be reached in 2035. These numbers suggest that the bulk of available lands will be committed within only a few decades (20-30 years).

Table 3-4. Highlands population in 2000 and estimates from the build-out analysis

	Total Population	Percent change from 2000
2000 census	1,372,423	--
Low-constraint scenario	2,026,301	47.6
High-constraint scenario	1,733,674	26.3

Under the low-constraint scenario, six different Highlands municipalities were already zoned in a manner that would allow more than a tripling of the population:

- Patterson Town (Putnam County, NY);
- Hardystown Township (Sussex County, NJ);
- Franklin Township (Warren County, NJ);
- Greenwich Township (Warren County, NJ);
- Harmony Township (Warren County, NJ); and
- White Township (Warren County, NJ).

Thirteen municipalities appeared to already be at or near build-out, with less than a 1 percent population increase under the low-constraint scenario. While this may mean that these municipalities have limited growth potential, it might instead reflect local zoning practices.

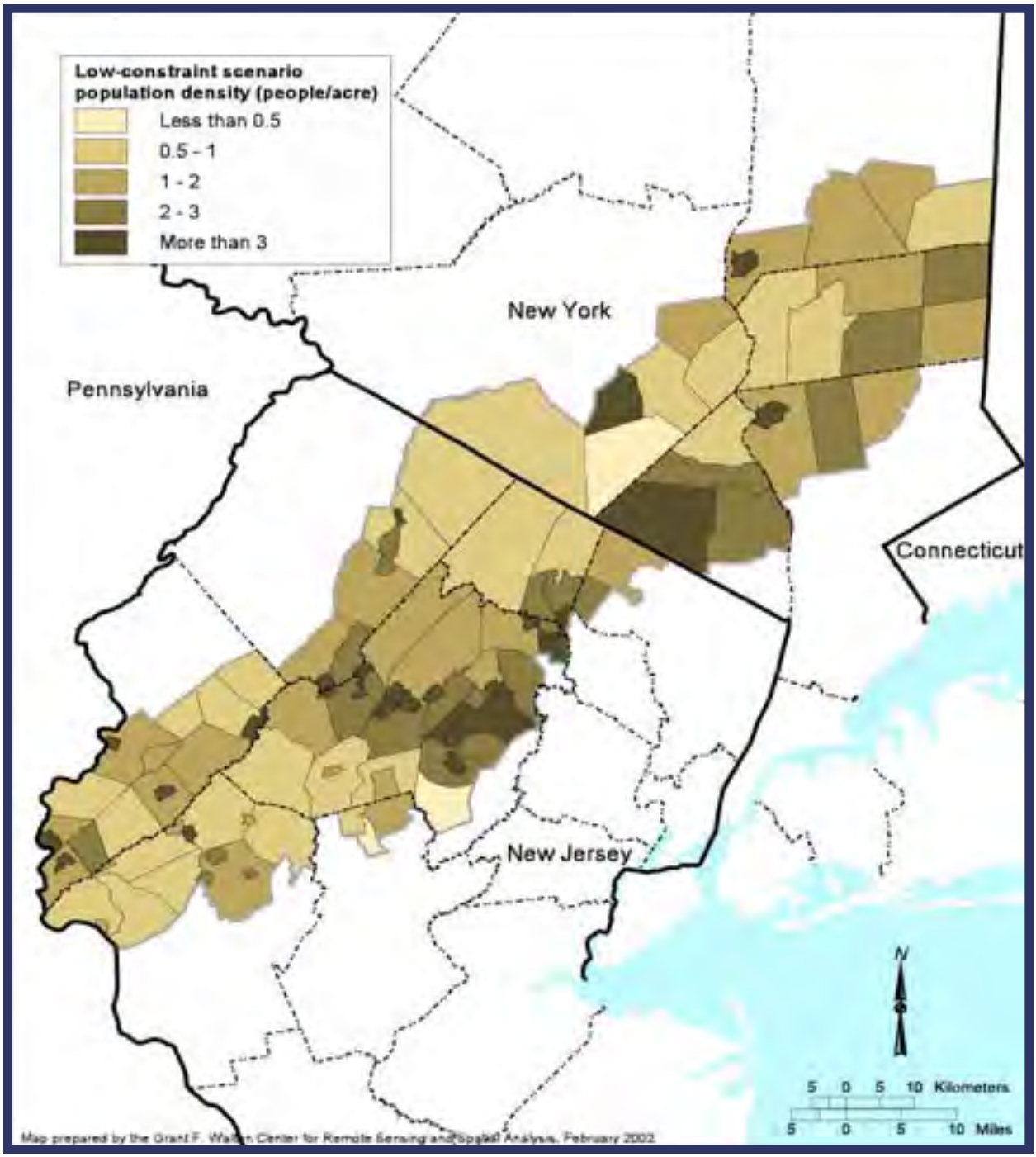
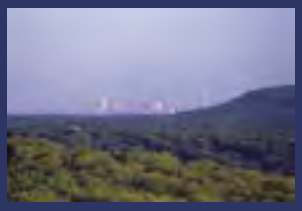


Figure 3-5. Population levels, low-constraint scenario. Population density under the low-constraint scenario of the build-out analysis differs significantly from that under the high-constraint scenario shown in Figure 3-6.



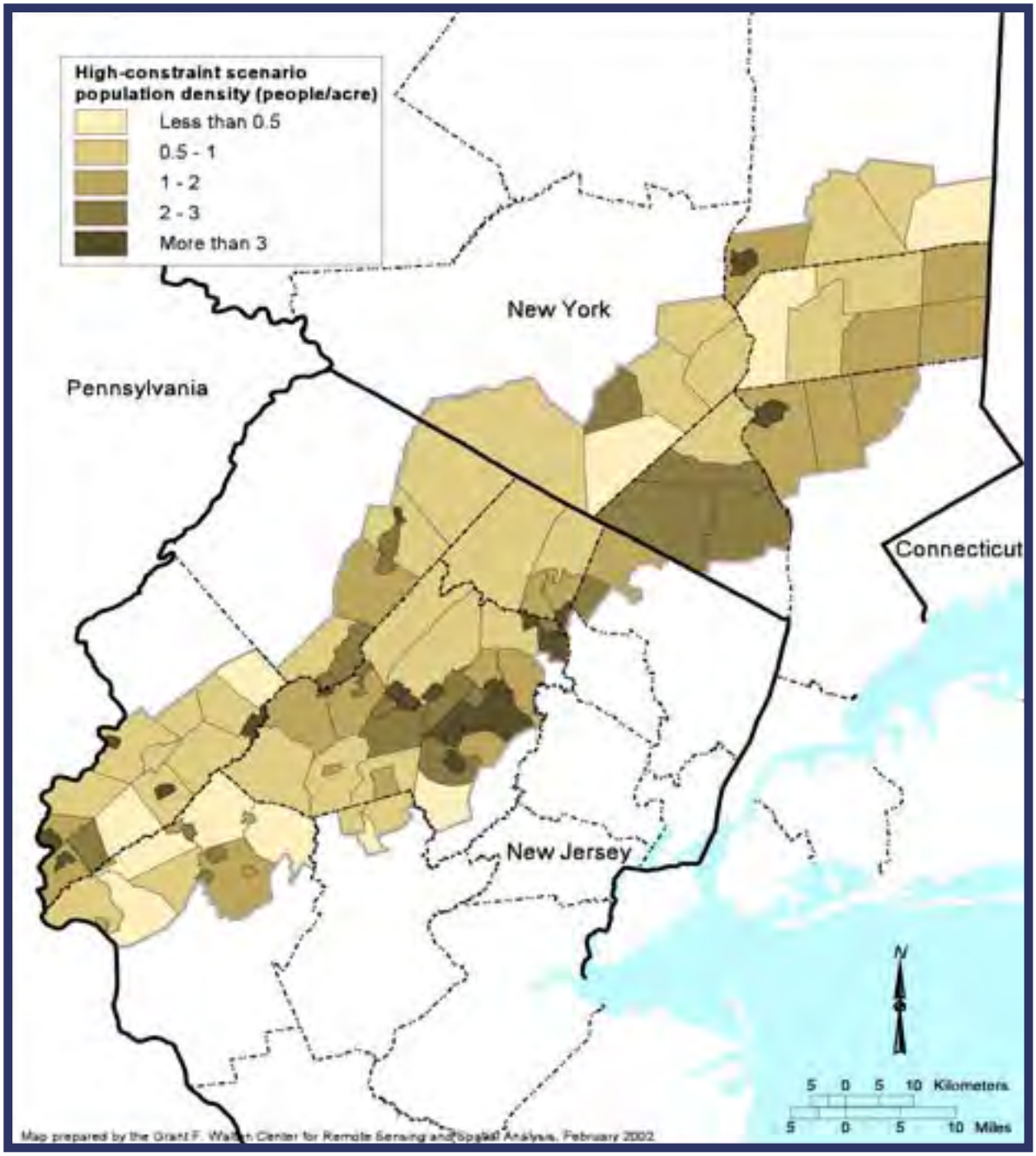


Figure 3-6. Population levels, high-constraint scenario. Population density would be much lower under the high-constraint scenario of the build-out analysis than under the low-constraint scenario shown in Figure 3-5.

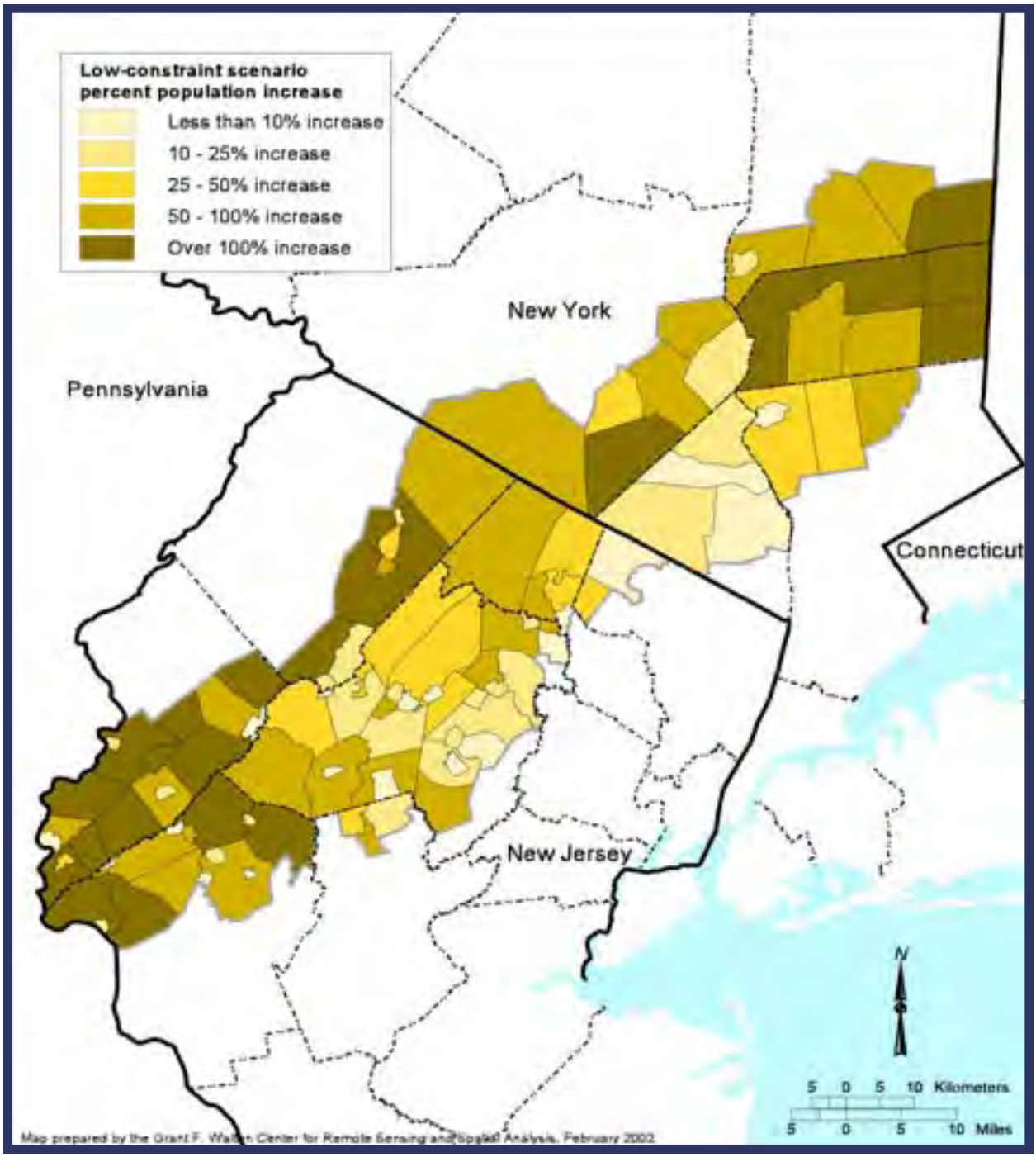


Figure 3-7. Population increase, low-constraint scenario. Under the low-constraint scenario of the build-out analysis, the Highlands population would increase by almost 50 percent from the population in 2000. This increase is almost double that modeled for the high-constraint scenario shown in Figure 3-8.

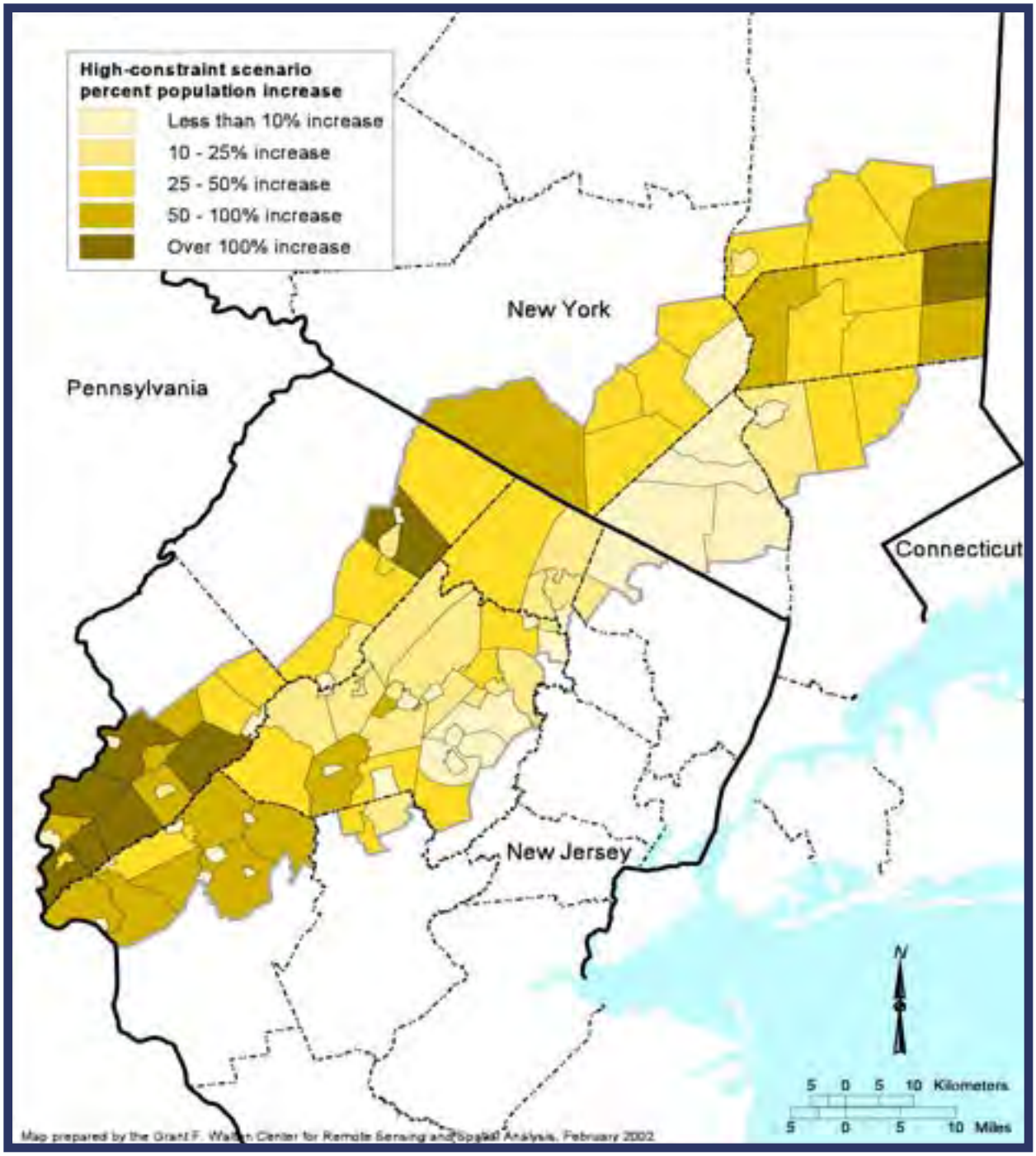


Figure 3-8. Population increase, high-constraint scenario. Under the high-constraint scenario of the build-out analysis, the Highlands population would increase by more than 25 percent from the population in 2000. This increase is a little more than half that modeled for the low-constraint scenario shown in Figure 3-7.

ECONOMETRIC ANALYSIS

The goal of the econometric analysis was to identify the forces involved in market-driven change and use those forces to identify lands most likely to change.

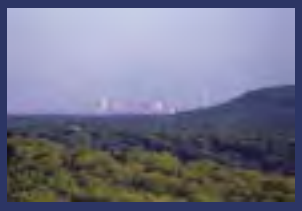
More than 4,000 randomly sampled points were compared across the Highlands. These points were selected from properties that were identified as undeveloped in 1995 and that were subject to market forces between 1995 and 2000. The analysis separated the points from properties that developed over that time period from those that did not.

The Highlands, as defined for this analysis, includes some extremely different areas. The unglaciated river valley farmlands of Hunterdon County are not subject to the same combination of market forces as are the ridgetops of the East Hudson Highlands. To reflect local processes, the Highlands was divided into four subregions, to reflect both policy differences (particularly across State lines) and physical patterns. The analysis did achieve a better "fit" for the regression curve using the subregions than for the total Highlands region.

A number of spatial variables were identified as being possible factors, with each sample point being evaluated for each variable. These factors were ultimately considered as part of the analysis:

- Distance to nearest existing developed lands;
- Participation in the Forest Stewardship Program (Appendix I);
- Floodprone areas;
- Prime farmland soils;
- Slope (angle of terrain);
- Distance to the nearest water body;
- Census measures of population density (by block group);
- Census measures of housing density (by block group);
- Census estimates of home value (by block group);
- Travel distance to employment centers;
- Travel distance to train stations;
- Travel distance to New York City;
- Zoning type (e.g., residential, commercial, industrial); and
- Zoning density (based on minimum lot sizes).

The randomly selected points and the full list of factors were analyzed using a statistical technique called multinomial logit regression. The analyses (run once for each of the four regions) identified the degree to which each factor was related to the change that occurred. Based on this past history of change from 1995 to 2000, these factors were updated and reevaluated to identify the current likelihood of change.



LIMITATIONS OF ECONOMETRIC ANALYSIS

While the econometric analysis is a useful tool, it is easily misinterpreted if the assumptions are not fully understood. Limitations include issues relating to:

- Specific factors,
- Limited history,
- Scale, and
- Economic assumptions.

One simple limitation is that the model is limited by the factors that it provides. Several important factors, like prior home sale values, were simply unavailable at a consistent level across the Highlands region.

Another important limitation is that some of the forces determining future development are almost impossible to model. Recent history is insufficient to predict how the more unusual parcels, like the larger, privately held tracts within Sterling Forest, might develop. It is also worth noting that the model is based on patterns of development over the years 1995-2000. Any short-term anomalous trends during that period could affect the model. An example might be a town that had a short building moratorium due to a problem with infrastructure, such as sewers or schools. Even though the circumstance no longer exists, the reduced development rate would still be reflected in the analysis.

The final likelihood of change analysis was performed at a regional scale resulting in data in a grid cell format (approximately 100- by 100-foot grid cells). However, the actual development pattern will occur at a resolution determined by existing property lines. For regional analysis, parcel maps are unavailable, so the grid cell approach is necessary. This approach provides a meaningful representation of market pressures at the regional scale, but it may not match well with individual parcels or provide the detail needed for local decisionmaking.

The econometric analysis is appropriate only for considering lands for which market forces can be considered to be in effect. This means that a property (such as a municipal property) that is being held for development is understood to have decisions about its development determined by more than simple free market economics. This does not mean that the property is not available for development, but it does suggest that the property is not affected by the same forces as other properties.

FUTURE CHANGE SCENARIOS: KEY FINDINGS

RESULTS OF THE ECONOMETRIC ANALYSIS

After analyzing past change, the model produced a complex formula for each of the four sub-regions describing the interaction of the factors impacting development. The formula was then applied to produce a map of likelihood of change (Figure 3-9). The map shows several areas as being most likely to change. The Interstate Highway 78, Interstate Highway 80, and Interstate Highway 87 corridors all appear as areas more likely for future development. The map also shows areas in which change is less likely to occur, or perhaps in which development will occur less intensely. Included are some of the northernmost and southernmost parts of the Highlands.

KEY FINDINGS:

- In the build-out analysis, **the low-constraint scenario identified** areas that would develop if existing policies (including zoning) were continued unchanged. Under this model, **the Highlands population could increase by 47.6 percent.**
- **The high-constraint scenario identified** areas that would develop if some policies (excluding zoning) were changed to increase constraints on future development. Under this model, **the Highlands population could increase by 26.3 percent.**
- The econometric analysis divided the Highlands into four subregions to reflect policy differences and physical patterns, especially across State lines. Results showed that **the Interstate Highway 78, Interstate Highway 80, and Interstate Highway 87 transportation corridors are most likely to be developed in the future**, while the northernmost and southernmost areas of the Highlands are least likely to change.

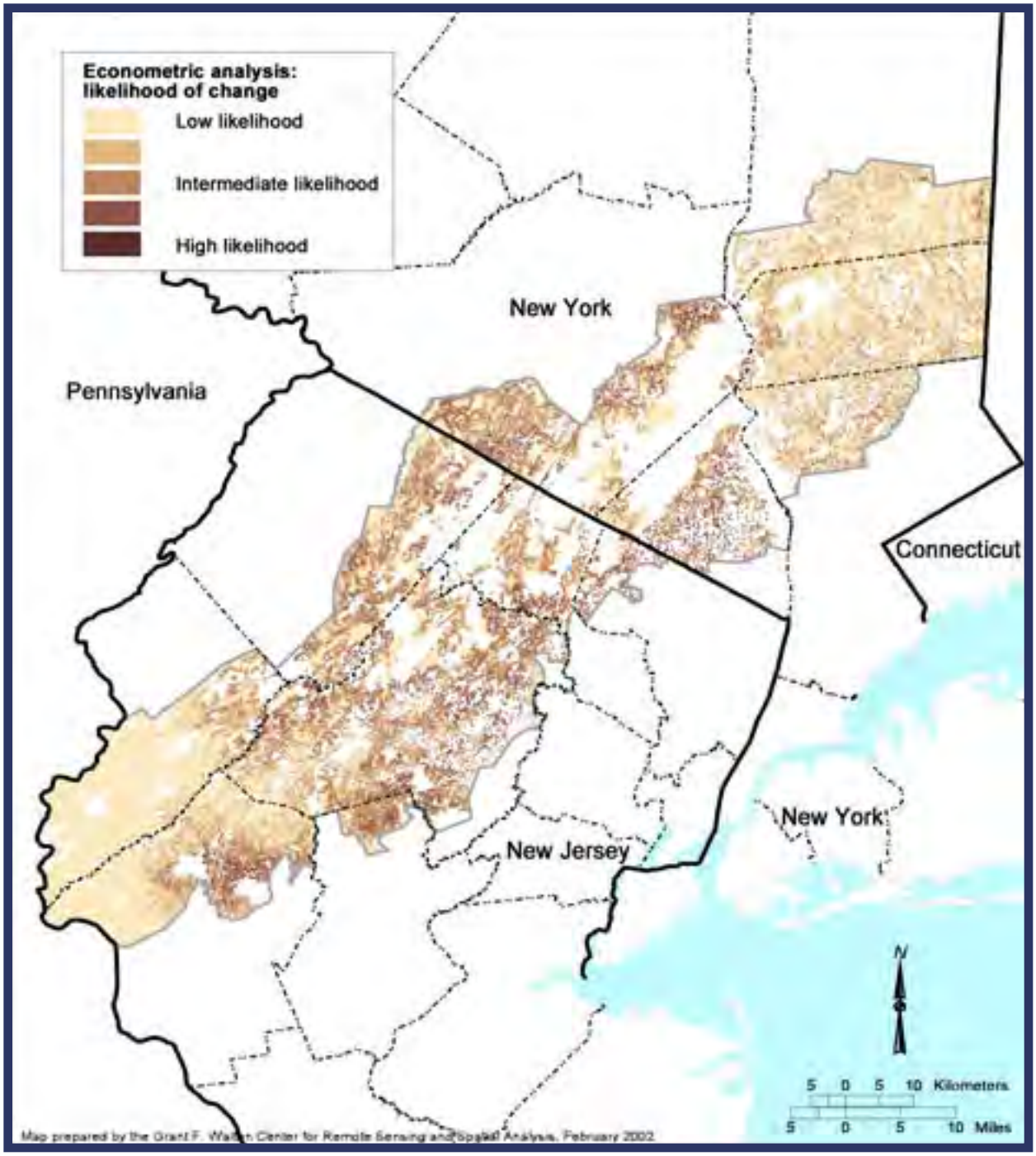


Figure 3-9. Likelihood of change. The econometric analysis identified areas that are most likely to change in the near future, given the history of land-use change in the Highlands from 1995 to 2000.

POSSIBLE CONSEQUENCES OF FUTURE CHANGE TO RESOURCES

CHANGES IN LAND USE AND LAND COVER

As continued human activity is the primary factor shaping the New York – New Jersey Highlands region, a better understanding of past and present trends in land use and land cover change was a critical component of this study. Accordingly, a land use and land cover analysis was undertaken with a twofold objective: (1) to provide a consistent assessment of present day (2000) land use and land cover across the two-State Highlands study area; and (2) to perform an analysis of land cover changes since 1972. A combination of Landsat Thematic Mapper and Multispectral Scanner satellite imagery, digital orthophotography, and existing State and county level data sets were used for the analysis. While the best possible effort was made to map land use and land cover with a high accuracy and consistent manner across the various time periods and entire study area, some error was inevitable. Due to the lesser reliability of the 1972 data set, more detailed change analyses excluded the 1972 data. Thus the land use and land cover data should be considered estimates with some margin of error. For more details of the analysis, see the New York – New Jersey Highlands Technical Report.

The Highlands contain a diversity of land uses and land covers. While extensive areas of the Highlands consist of large contiguous tracts of semiwilderness forest and watershed lands, the Highlands study area also contains other landscape types including river valley agricultural areas with scattered villages; rural areas with a mix of housing, woods, and fields; suburban towns; and small cities. The land use and land cover analysis shows that while forest land still dominates, human development has increased steadily from 1972 to 2000 (Table 3-5). Typical of the spatial patterns associated with urban sprawl, the tracts of new development are widely dispersed throughout the New York – New Jersey Highlands region (Figure 3-10). Both farm and forest land have been converted to residential and commercial land uses to meet the demands of a growing regional population. Analysis of the change during 1995 to 2000 indicates that the annual rate of forest loss to development is increasing, while the amount of farmland loss is decreasing (Table 3-6). This shift may reflect the amount of readily available land close to the New York City metropolitan area with farmland developed first and a more recent shifting to developing forested tracts.

Table 3-5. Land cover (acres) in the Highlands, 1972 to 2000

Land Cover	1972	1984	1995	2000
Developed	197,002	278,999	318,768	344,569
Farmland/Grassland	223,732	208,790	184,190	176,200
Forest	804,766	757,115	736,996	721,293
Wetland	127,312	100,309	103,556	102,254
Barren	3,201	10,069	10,262	9,652
Water	61,946	62,587	64,502	64,305
Total*	**1,417,959**	**1,417,869**	**1,418,273**	**1,418,273**

*Totals differ due to rounding.

Table 3-6. Rates of land cover change in the Highlands, 1984-2000

	1984-1995		1995-2000	
Land type	Area change	Percent change	Area change	Percent change
Developed*	+39,769 acres +3,615 acres/yr	+14.2 % +1.3 %/yr	25,801 acres 5,160 acres/yr	+8.1 % +1.6 %/yr
Forest/ Wetland**	-16,873 acres -1,534 acres/yr	-2.0 % -0.2 %/yr	-17,004 acres -3,400 acres/yr	-2.0 % -0.4 %/yr
Farmland/ Grassland***	-24,600 acres -2,236 acres/yr	-11.8 % -1.1 %/yr	-7,990 acres -1,598 acres/yr	-4.3 % -0.9 %/yr

*Developed land covers include impervious, bare, or partially vegetated land surfaces due to commercial, industrial, residential and transportation land uses.
**Forest/wetland land covers include upland and wetland forests, scrub/shrub and emergent vegetation communities.
***Farmland/Grassland includes agricultural lands (including cultivated land, pastures and hay fields), managed grasslands (e.g., large areas of mowed and irrigated/fertilized lawn and golf courses) and unmanaged grassland.

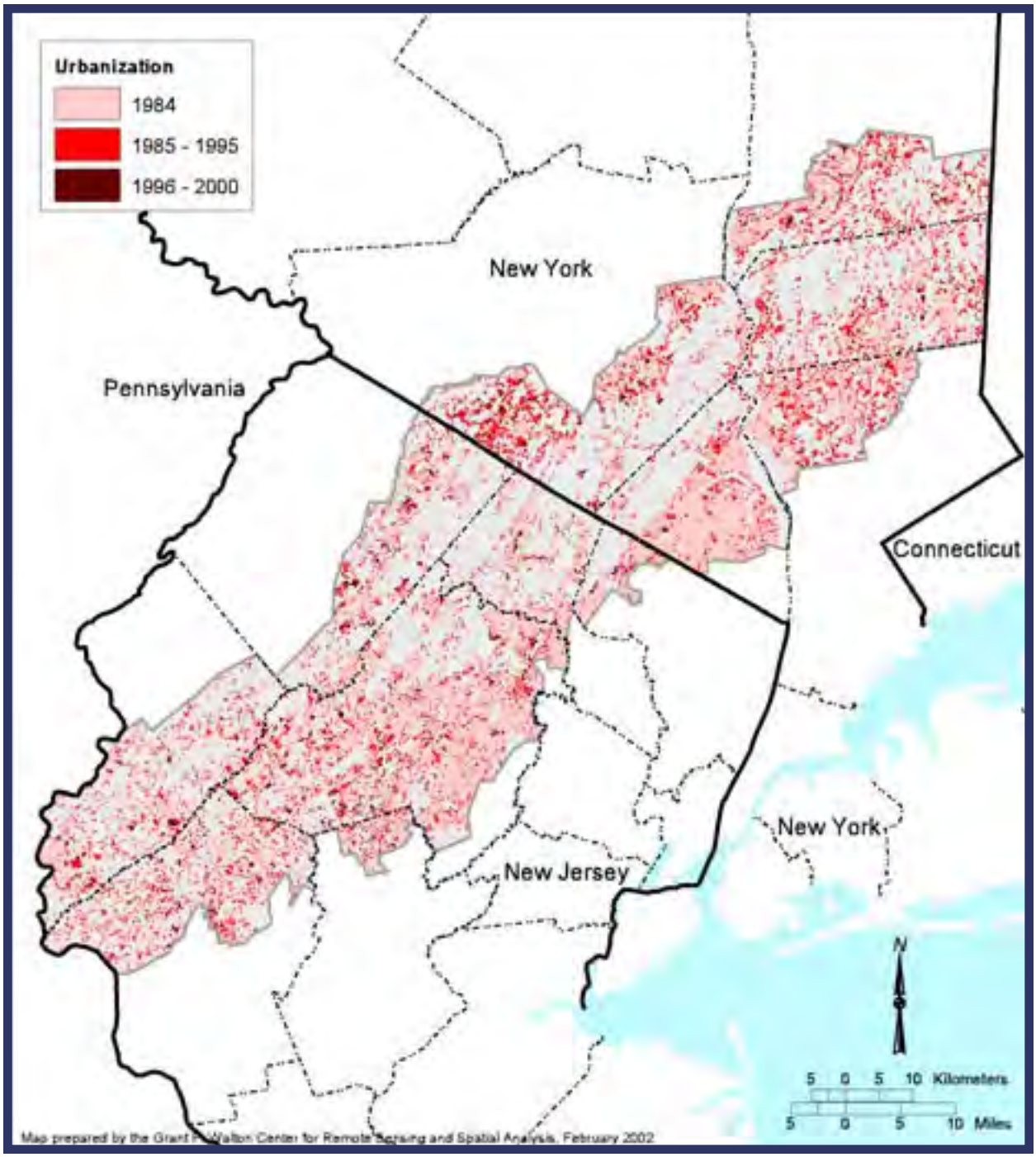


Figure 3-10. Urban development in the Highlands. Estimated land use and land cover in the New York – New Jersey Highlands show that development has increased steadily from 1984 to 2000. Typical of the spatial patterns associated with urban sprawl, the tracts of new development are widely dispersed throughout the Highlands region.

Key Findings:

- In 2000, **the Highlands study area was dominated by upland forest land cover types at 51 percent** of the total Highlands area, followed by developed land at 24 percent, farmland/grassland at 12 percent, and wetlands/water at 12 percent.
- **Developed land increased**, and conversion of forest/wetland and farmland/grassland continued from 1985 to 2000; however, **the rate of conversion of farmland/grassland slowed** during that time.

LANDSCAPE INDICATORS OF FOREST AND WATERSHED INTEGRITY

There has been a great push by Federal land-management agencies to develop land cover data sets and indicators that are suitable for measuring and monitoring land cover and associated environmental change across broad landscape regions. A suite of landscape-level indicators were chosen to quantify important components of the Highlands land use and land cover as one means of measuring the condition of the New York – New Jersey Highlands forests and watersheds:

1. Percentages of altered and unaltered land cover;
2. Indices of forest fragmentation;
3. Percentage of impervious surface cover; and
4. Percentage of the riparian areas of permanent streams that is in a vegetated, as compared to developed, condition.

The land use and land cover mapping, described under Changes in Land Use and Land Cover earlier in this section, served as the basis for the development of these landscape indicators. They were analyzed on a watershed basis, aggregating results to the level of Hydrologic Unit Code (HUC) 11 watersheds, which have an average area of about 50 square miles. There are 51 complete or partial HUC 11 watersheds within the New York – New Jersey Highlands study area. The four indicators were calculated for each of the 51 watersheds for each of the 3 years for which land use and land cover were established—1984, 1995, and 2000. This was done to permit analysis of existing trends and to estimate possible future conditions (low- and high-constraint buildout scenarios). The relationships between the selected landscape indicators and independently measured environmental parameters were examined to assist in identifying thresholds that may signify high potential for environmental degradation.

The amount of altered land within a watershed provides a useful indicator of watershed condition and the likelihood of degraded water quality. Altered land includes the following land use and land cover types that have minimal native vegetation (e.g., forest and wetlands): developed, farmland/grassland, and barren land cover types. Developed land represents land that is in some form of urban land use (i.e., commercial, industrial, residential). Developed land may actually have several different types of land covers, e.g., development or impervious surface (buildings, roads, driveways, parking lots, sidewalks), lawns, and bare soil.

Analysis of altered versus unaltered land was conducted to evaluate the percentage of the watershed that is or might be in land cover types that would likely have a negative impact on water quality, due to factors such as point and nonpoint source pollution and soil erosion (see Changes in Water Resources later in this section). No watershed with more than 50 percent of its area in developed land had high quality surface waters, based on New Jersey Department of Environmental Protection and New York State Department of Environmental

Conservation State stream water classification data. The basins with the most degraded aquatic biological communities were those with approximately 50 percent developed land cover. The indicator analysis shows a general trend towards increasing altered land cover between 1984 and 2000 (Figure 3-11). Depending on the build-out scenario, the number of watersheds with more than 50 percent altered land cover could more than double (Figure 3-11). This increase in altered land indicates that threats to Highlands water quality are expected to increase. For more information, see the New York – New Jersey Highlands Technical Report.

Impervious surface cover is increasingly being used as a landscape level indicator of nonpoint source pollution and watershed health. Impervious surface cover reduces the amount of infiltration of water into the soil and increases runoff directly to stream systems, exacerbating stream "flashiness" and flooding problems. The amount of impervious surface within each HUC 11 watershed basin was estimated based on the land use and land cover data. Watersheds with more than 10 percent impervious surface were flagged as likely showing negative impacts on water quality and stream flashiness. A 10 percent impervious surface threshold is widely used in the water resources literature (Arnold and Gibbons 1996, Schueler 1998) and is backed up by our findings in the Highlands. The indicator analysis shows a general trend towards increasing impervious surface cover between 1984 and 2000 (Figure 3-12). Depending on the build-out scenario, the number of watersheds with greater than 10 percent impervious surface cover could more than triple or quadruple (Figure 3-12). This increase in impervious surface cover indicates that negative impacts to Highlands water quality are expected to increase. For more information, see the New York – New Jersey Highlands Technical Report.

Protecting wetlands and floodplains and establishing riparian buffer strips around lakes and streams where human development is excluded or minimized are "best management practices" that are often advocated as a means of reducing the impact of developed land uses on surface water quality. In addition to reducing nonpoint source pollution, soil erosion, and flooding impacts, riparian buffer zones serve as vital habitat for both upland and wetland-dependent species.

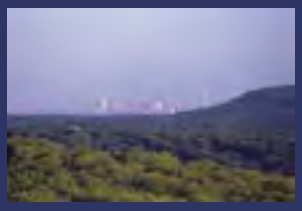
The percent of the riparian zones in altered and unaltered land covers was estimated on a HUC 11 watershed basis in the study area. The indicator analysis shows that alteration of riparian zones increased between 1984 and 2000 (Figure 3-13). The two build-out scenarios show a very different response in relation to riparian zone protection. The low-constraint scenario shows a large increase in riparian zone development and alteration, while the high-constraint scenario (which incorporates wider wetland buffers) remains largely unchanged from the present situation. The results of the high-constraint build-out scenario suggest that increasing the wetland buffer width will help to protect sensitive riparian zones (and thereby surface water quality), even with increasing development (Figure 3-13).

POSSIBLE CONSEQUENCES OF CHANGE: FOREST AND WATERSHED

Large expanses of contiguous forest are one of the notable characteristics of the Highlands. These upland and wetland forests serve to protect the integrity of ground water and surface water supplies as well as serve as critical habitat to a number of plant and animal species. Two parameters were analyzed as indicators of forest integrity: (1) the amount of interior or core forest habitat (i.e., the forest that is unfragmented with minimal "edge") in each watershed basin, and (2) the percent of overall forest cover by breeding bird atlas survey blocks (Andrle and Carroll 1988, Walsh and others 1999). The indicator analysis shows that the amount of overall forest and the unfragmented interior forest decreased between 1984 and 2000 (Figure 3-14). Under the build-out scenarios, the amounts of these indicators would continue to decline, suggesting that the integrity of the Highlands forests would be further compromised (Figure 3-14). For more information, see the New York – New Jersey Highlands Technical Report.

The analysis of landscape indicators coupled with the build-out analysis was developed to serve as a planning tool to provide a way to analyze "what if" scenarios. It is not an "absolute" prediction of future conditions at any particular point in time. Rather, it suggests what might be expected to happen based on existing patterns and trends and under the various assumptions contained in the build-out analyses.

The build-out scenarios suggest a very different picture of the Highlands region than what currently exists. After build-out, large areas of presently rural landscape would be replaced with tract-style development and dispersed large-lot housing, leading to a more suburban-mixed rural landscape. Extensive areas of river valley farms would be converted to large lot development and "farmettes," further isolating "working" farms that are presently part of New York and New Jersey's Farmland Preservation Programs (Appendix I). Existing public open space areas would provide a remnant core of forested upland in the north-central Highlands but would become further isolated as the existing forest matrix undergoes continued conversion and fragmentation.



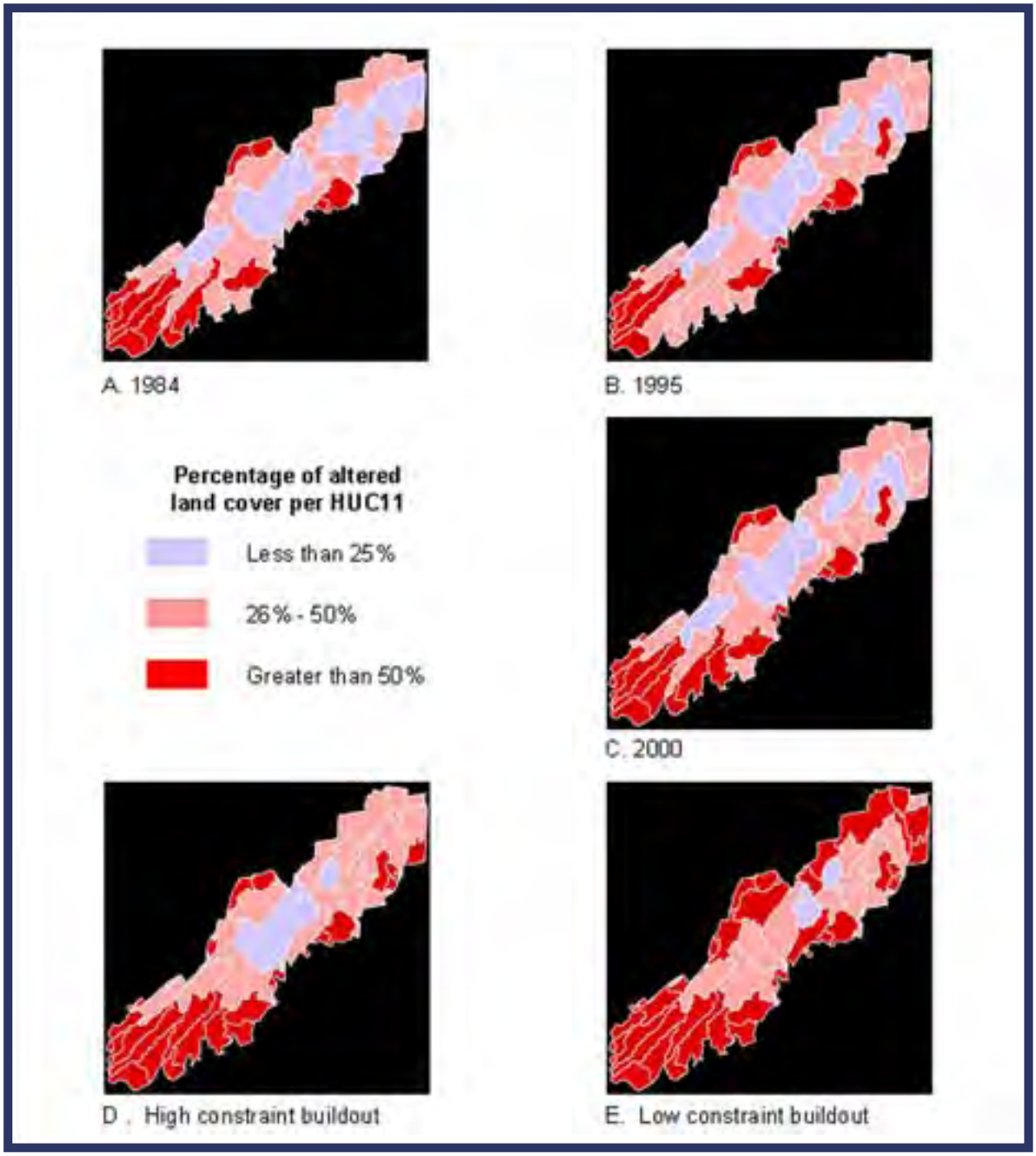


Figure 3-11. Change in land cover. Analysis of land cover in HUC 11 watersheds showed increasing altered land from 1984 to 2000 (A,B,C) and in the build-out analysis (D,E). Hydrologic Unit Code 11 refers to subwatersheds with an average area of about 50 square miles. Altered land greater than 50 percent has a negative effect on water quality.

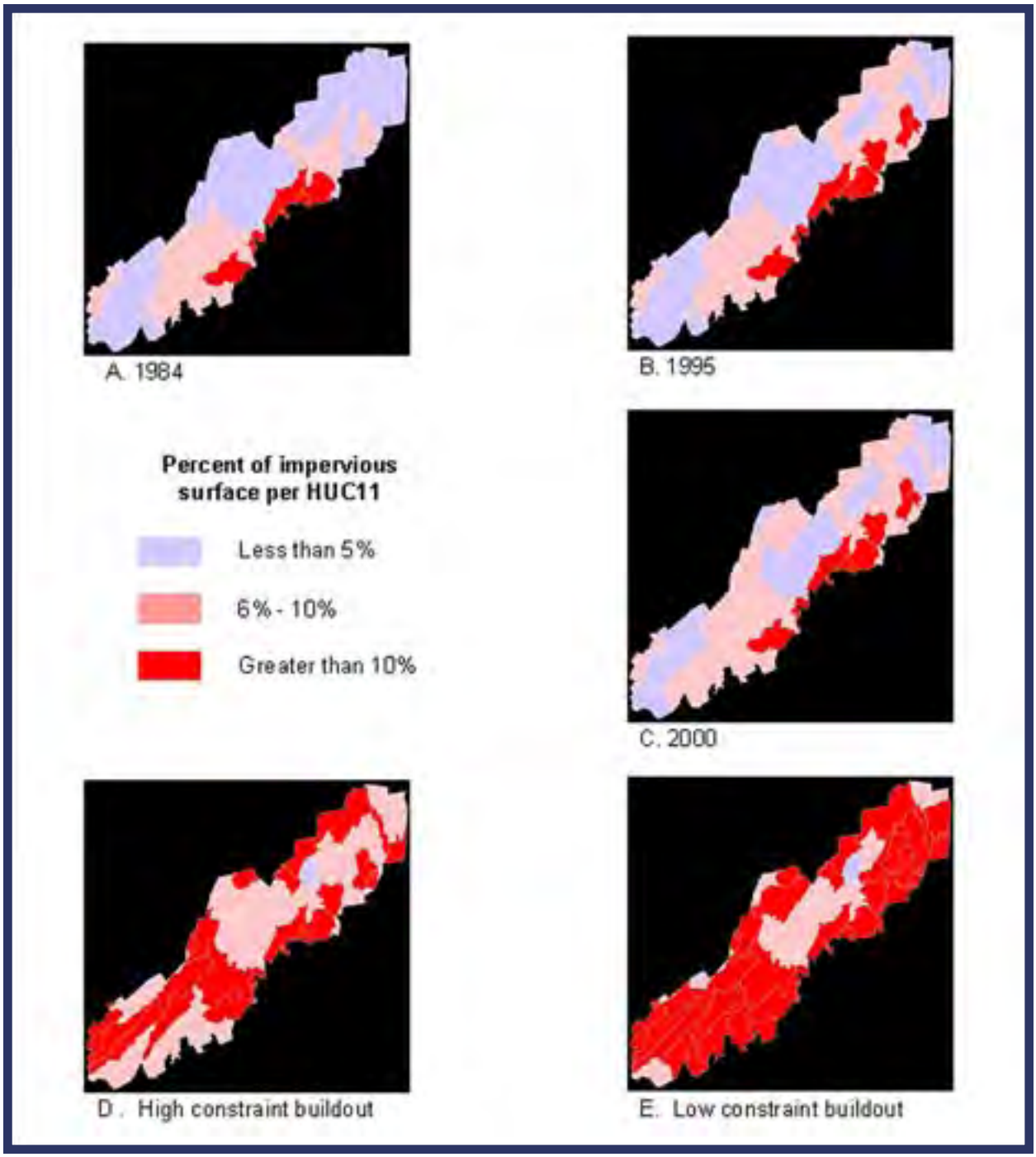
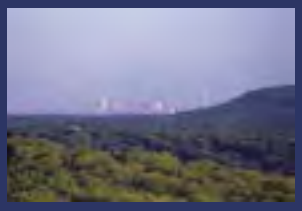


Figure 3-12. Change in impervious surface cover. Analysis of land cover in HUC 11 watersheds showed increasing impervious surface cover from 1984 to 2000 (A,B,C) and in the build-out analysis (D,E). Hydrologic Unit Code 11 refers to subwatersheds with an average area of about 50 square miles. Impervious cover greater than 10 percent is likely to be associated with negative impacts on water quality and stream "flashiness."



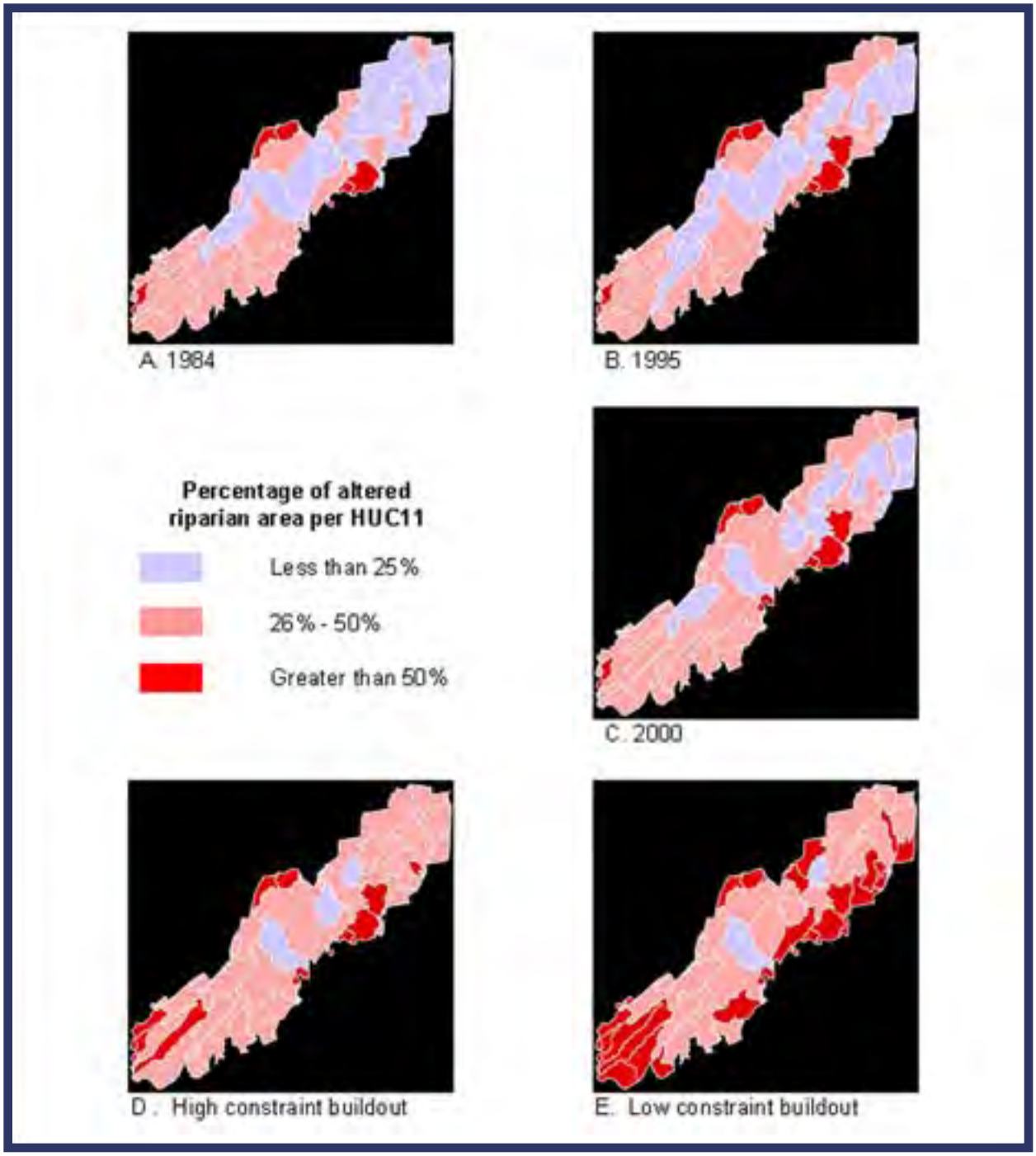


Figure 3-13. Change in riparian zones. Analysis of land cover in HUC 11 watersheds showed an increase in altered riparian zones from 1984 to 2000 (A,B,C) and a large increase in altered riparian zones under the low-constraint scenario of the build-out analysis (E). Under the high-constraint scenario (D), however, riparian zones show little change from 2000. Hydrologic Unit Code 11 refers to subwatersheds with an average area of about 50 square miles. Intact riparian zones reduce the impact of development on surface water quality.

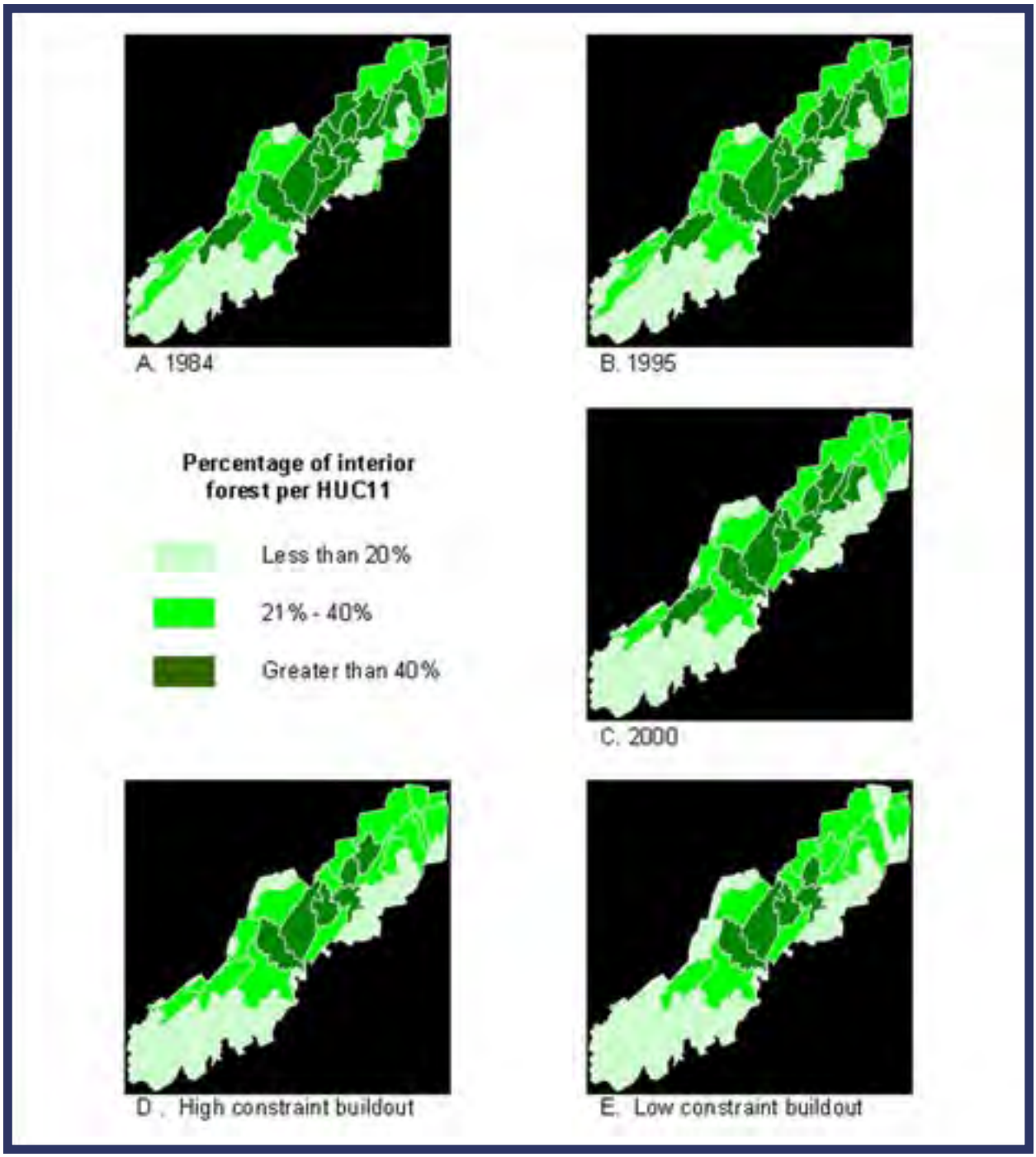


Figure 3-14. Change in interior forest. Analysis of land cover in HUC 11 watersheds showed a decrease in unfragmented forest from 1984 to 2000 (A,B,C) and in the build-out analysis (D,E). Hydrologic Unit Code 11 refers to subwatersheds with an average area of about 50 square miles. Loss of unfragmented forest compromises forest integrity and wildlife habitat.

KEY FINDINGS:

- The analysis of Highlands watersheds by the U.S. Geological Survey demonstrates that **watersheds with more than 50 percent altered land show compromised water quality.**
- **The number of watersheds with more than 50 percent altered land cover could more than double in the future.** There was a general trend toward increasing altered land cover during the 1980s and 1990s, with a third of watershed basins dominated by altered land covers (i.e., greater than 50 percent developed, cultivated, or barren land) in the year 2000. Approximately 50 percent of basins in the high-constraint scenario and more than 70 percent of basins in the low-constraint scenario have more than 50 percent altered land cover.
- **As impervious surface cover increased above 10 percent, the overall stream water quality fell from a high water quality standard.** A comparison of stream water quality classification and the percentage of impervious surface cover on a HUC-11 watershed basis for New Jersey basins showed that those basins that were ranked as having the highest water quality had an impervious surface cover of 10 percent or less.
- **The number of watersheds with more than 10 percent impervious surface cover could more than triple to quadruple.** Analysis shows a general trend towards increasing impervious surface cover, with more than 15 percent of the watershed basins in the year 2000 surpassing the 10 percent threshold. More than 50 percent of basins in the high-constraint scenario to more than 70 percent of basins in the low-constraint scenario had more than 10 percent impervious surface cover.
- **The alteration of riparian zones increased between 1984 and 2000. In 2000 approximately 75 percent of watersheds had riparian zones with more than 25 percent altered land cover.** A smaller subset of watersheds (approximately 13 percent), primarily those in agriculture-dominated landscapes, had more than 50 percent of the riparian zone in altered land covers.
- **The two build-out scenarios show different responses in relation to riparian zone protection.** In the high-constraint scenario (which incorporated wider wetland buffers), riparian zone development and alteration increased only slightly (to 20 percent) from the situation in 2000, while the low-constraint scenario showed a large increase (to 47 percent). The results of the high-constraint build-out scenario suggest that increasing the buffer distance will help to protect sensitive riparian zones and thereby enhance surface water quality.
- **A threshold of 70 percent or more forest cover was identified as prime habitat for interior nesting birds and raptor species.** Analysis of the 1995 New Jersey breeding bird atlas survey block data in relation to the Highlands land use and land cover indicates a significant decline

in the number of observed forest interior species at both the 70 percent and 25 percent levels of forest cover. In the year 2000, 22 percent of the survey blocks were considered prime forest habitat for forest interior nesting birds or raptors. Under the low-constraint scenario, the number of prime forest habitat blocks decreased by 38 percent to where only 13 percent of the Highlands were considered prime forest habitat.

- **Analysis of interior forest cover shows a steady decline** from 15 watersheds in 1984 to only 9 watersheds in 2000 that have more than 40 percent interior forest cover. **Under the build-out scenarios, the amount of interior forest habitat further decreased**, especially in the low-constraint scenario, in which only 5 watersheds had more than 40 percent interior forest.

CHANGES IN WATER RESOURCES

Land use can affect the quality, quantity, and distribution of water recharging an aquifer or running overland to streams. An increase in impervious surfaces, such as parking lots, buildings, and roads, decreases the amount of land through which precipitation can infiltrate and recharge an aquifer. Water that does not infiltrate the ground increases the amount of runoff, with potential increases in soil erosion, flooding, and surface-water contamination. The loss of recharge water also changes the timing of streamflow. Less ground water flows to streams as baseflow during dry periods and more surface water flows to streams as immediate runoff during wet periods. These changes in the hydrology of a watershed are accompanied by ecological and hydrological impacts: increased flooding during high-intensity rain storms, stressed ecosystems, decreased water-supply storage during droughts, and degraded water quality.

WATER BUDGET

The effect of the high- and low-constraint scenarios on Highlands water budgets were evaluated using the watershed model described in this section. In this model, projected increases in impervious surfaces and ground water withdrawals drive the change in water budget components between 1995 and the build-out scenarios. Model simulations show little change in water budgets between high- and low-constraint scenarios. Therefore, the low-constraint scenario was used because it represents the worst-case conditions.

Model-simulated differences in runoff, baseflow, total streamflow, and evapotranspiration between 1995 conditions and the low-constraint scenario are shown in Figure 3-15 for 182 HUC 14 subwatersheds plotted in order of increasing impervious surface cover. (Subwatersheds that are designated by HUC 14 have an average area of about 8 square miles.) Trend lines clearly show the relationship of increasing impervious surface to each water budget component. As the percentage of impervious surface in a subwatershed increases, direct runoff increases, baseflow decreases, total streamflow increases (runoff increases more than baseflow decreases), and evapotranspiration decreases.

The increased rate at which the components deviate from 1995 conditions for watersheds with a projected increase of 15 percent or more impervious surface cover is also significant. The degree of change is measured in inches per year over a drainage area. To bring this into perspective, note that average mean annual streamflow for Highlands watersheds is about 25 inches per year, average baseflow is about 18.5 inches per year, and average runoff is about 6.75 inches per year. Figure 3-15 suggests a potential 50 percent or more increase in runoff in watersheds that are projected to have an increase in impervious surface of 15 percent or greater. The trend line for baseflow suggests about a 10 percent decrease in baseflow.

POSSIBLE CONSEQUENCES OF CHANGE: WATER RESOURCES

Figure 3-16 shows the degree to which streamflow characteristics of runoff and baseflow are predicted to change at the subwatershed scale based on the change between the simulated water budgets for 1995 and the low-constraint scenario. The areas of moderate and greatest change are directly related to the increase in impervious surface (Figure 3-15) and water withdrawals. These areas include subwatersheds drained by the Wallkill, Lamington, Musconetcong, Pequest, Rockaway, Pequannock, Ramapo, and Pompton Rivers, and Lopatcong and Pohatcong Creeks. The greater the degree of change in streamflow characteristics, the more these watersheds would show increases in runoff, decreases in ground water recharge, and decreases in stream baseflow. Increased monitoring of ground- and surface-water quality and quantity is warranted in areas expected to undergo significant development, particularly in areas where there is little existing data.

AVAILABLE WATER

A water budget analysis provides an estimate of how water moves through a watershed, but cannot directly determine the amount of water available to meet increased water-supply needs without overstressing the resource. Safe yield, which indicates how much water a surface water reservoir can provide based on the drought of record, has been calculated for all surface water reservoirs in the Highlands, as was discussed in Section 2 under Surface Water—Streams, Rivers, and Reservoirs. Ground water resources also have sustainable or dependable yields (New Jersey Department of Environmental Protection and Energy 1992). Continuous declines in ground water levels, adverse impacts upon other wells, and unacceptable depletion of streamflow within a watershed are indicators that the sustainable yield of ground water is being exceeded.

Quantifying the sustainable yield from a ground water source is difficult. For planning purposes, the New Jersey Statewide Water Supply Plan (New Jersey Department of Environmental Protection 1996) assumed that 20 percent of ground water recharge is available for human use with no acceptable regional impacts in noncoastal plain aquifers. There are concerns, however, with using the 20 percent threshold for watershed-specific management decisions (New Jersey Water Supply Authority 2000). Taking these concerns into account, and for the purpose of analysis, both a 20 percent and 10 percent threshold of ground water recharge was used to determine Highlands watersheds that are the most sensitive to current and forecasted increases in ground water withdrawals.

Model-calculated baseflow within a HUC 11 watershed was assumed to equal ground water recharge within that watershed. Ground water withdrawals from the 1995 and the low-constraint development simulations were subtracted from 20 percent and 10 percent of the total ground water recharge for each watershed. The results are displayed for 1995 in Figure 3-17 and for the low-constraint scenario in Figure 3-18. For 1995 conditions, ground water withdrawals exceeded 20 percent of ground water recharge in the HUC 11 watershed drained by the Whippany

River. This result is consistent with long-term water-level declines in the Whippany River basin that indicate ground water withdrawals are exceeding the rate of recharge to the aquifer (Illustration 2-2B, page 18). Using the 10 percent threshold of ground water recharge to represent sustainable yields, HUC 11 watersheds drained by the Ramapo River in New York and New Jersey, the upper Musconetcong River, the Pequest River, and tributaries of the upper Delaware River in Warren County, New Jersey—in addition to the Whippany—are the most sensitive to ground water withdrawals.

Based on the predicted population increase for the low-constraint scenario and water use of 85 gallons per day per person, an estimated additional 52.4 million gallons per day of ground water was assumed to be withdrawn from aquifers underlying the watersheds in the modeled area. The results of taking the difference of the total withdrawals from 20 percent and 10 percent of model calculated baseflow for the low-constraint scenario is shown in Figure 3-18. Ground water withdrawals exceeded 20 percent of aquifer recharge for this scenario in watersheds drained by the Ramapo, Whippany, and Pequest Rivers, upper Delaware tributaries, and Lopatcong Creek. Using a sustainable yield threshold of 10 percent, watersheds drained by the Rockaway and Upper Musconetcong Rivers were added to the watersheds previously mentioned as being the most sensitive to ground water withdrawals.

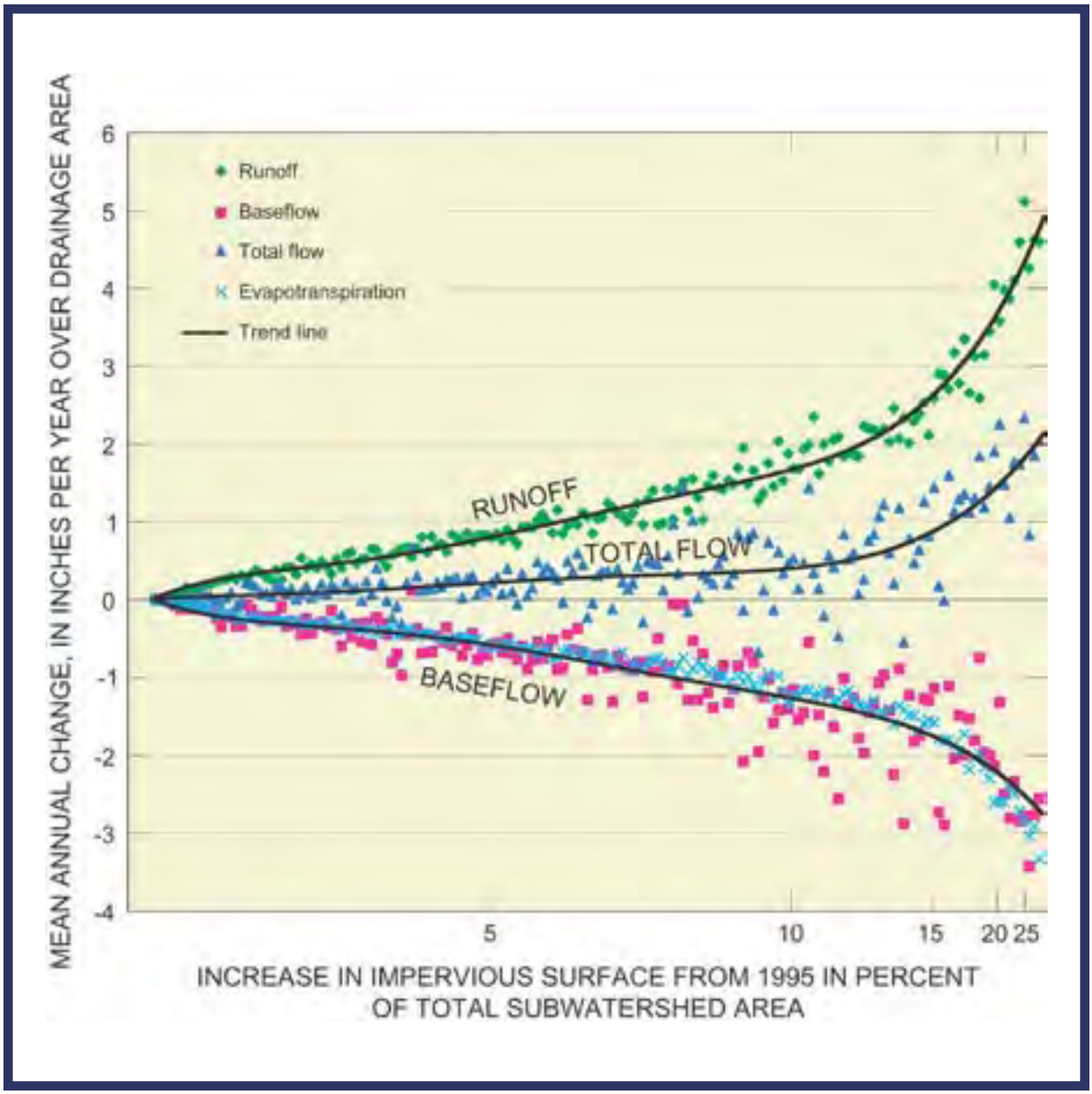
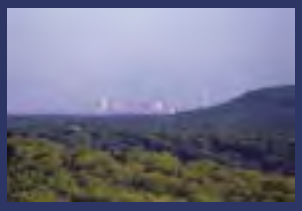


Figure 3-15. Effect of impervious surfaces on streamflow. Changes in streamflow characteristics and evapotranspiration are directly related to increasing impervious surface area, as shown here for 182 HUC 14 subwatersheds in the Highlands. Hydrologic Unit Code 14 refers to subwatersheds with an average area of about 8 square miles.



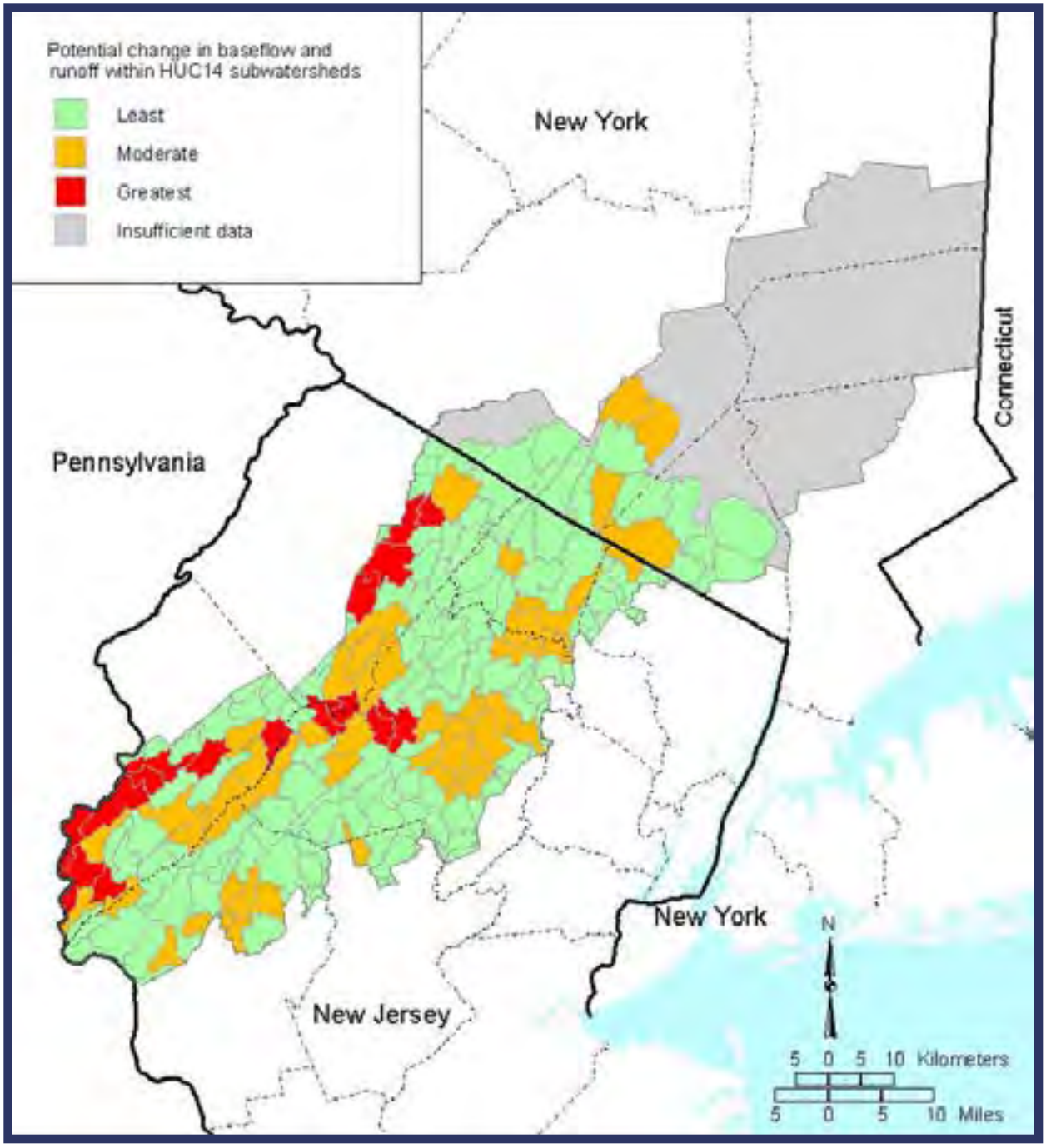


Figure 3-16. Predicted changes in streamflow. Different degrees of change in streamflow characteristics are predicted for HUC 14 subwatersheds under the low-constraint scenario of the build-out analysis, depending on the amount of impervious surface and water withdrawals in an area. Increased surface runoff, decreased ground water recharge, and decreased ground water discharge to streams are associated with greater degrees of predicted change. Hydrologic Unit Code 14 refers to subwatersheds with an average area of about 8 square miles.

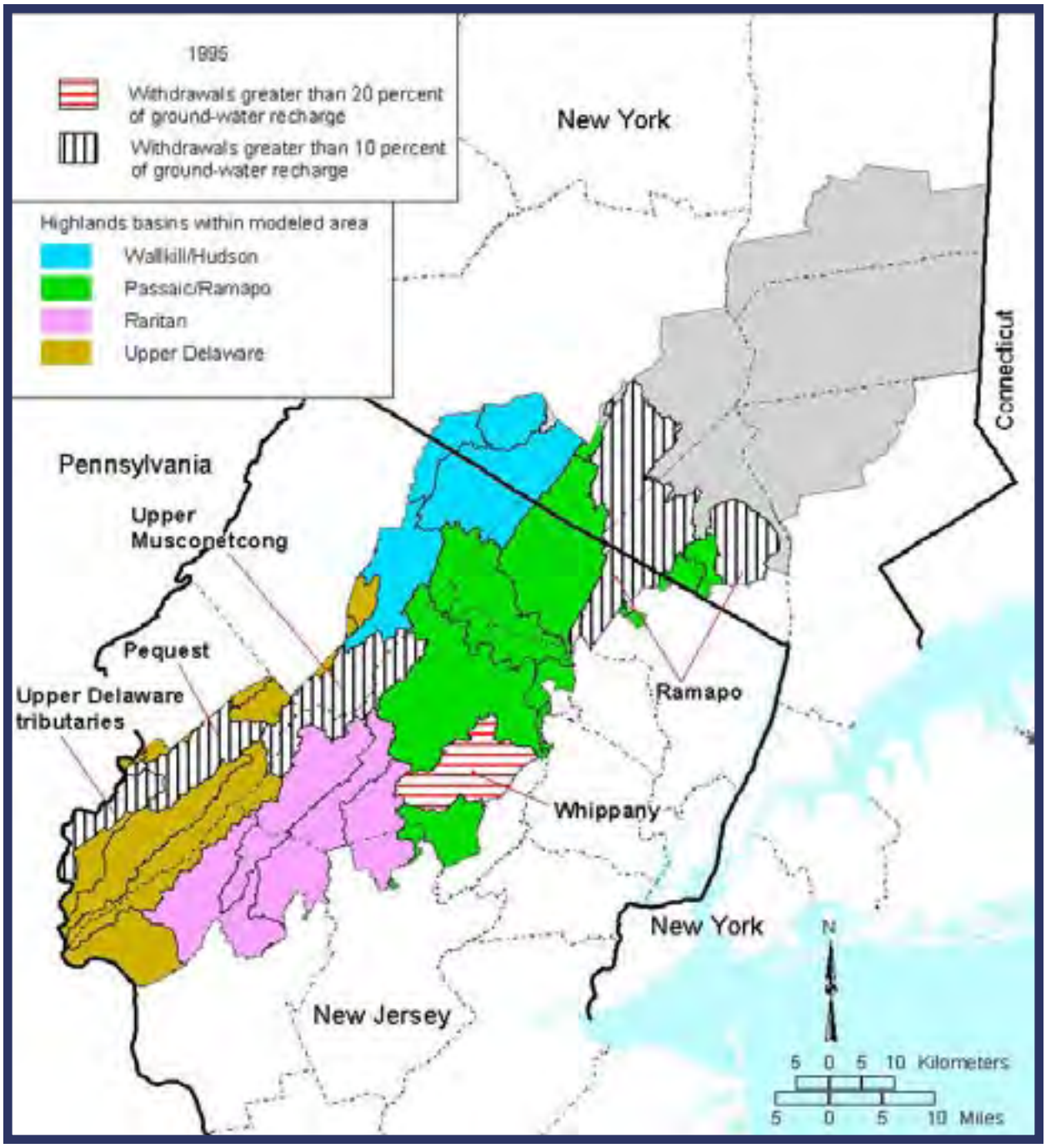


Figure 3-17. Sustainable water yield, 1995. This map shows HUC 11 watersheds where ground water withdrawals exceeded 20 percent and 10 percent of the estimated ground water recharge in 1995. Thresholds of 20 percent and 10 percent of estimated recharge were used to determine watersheds most sensitive to 1995 ground water withdrawals. Hydrologic Unit Code 11 refers to subwatersheds with an average area of about 50 square miles. Compare Figure 3-18.

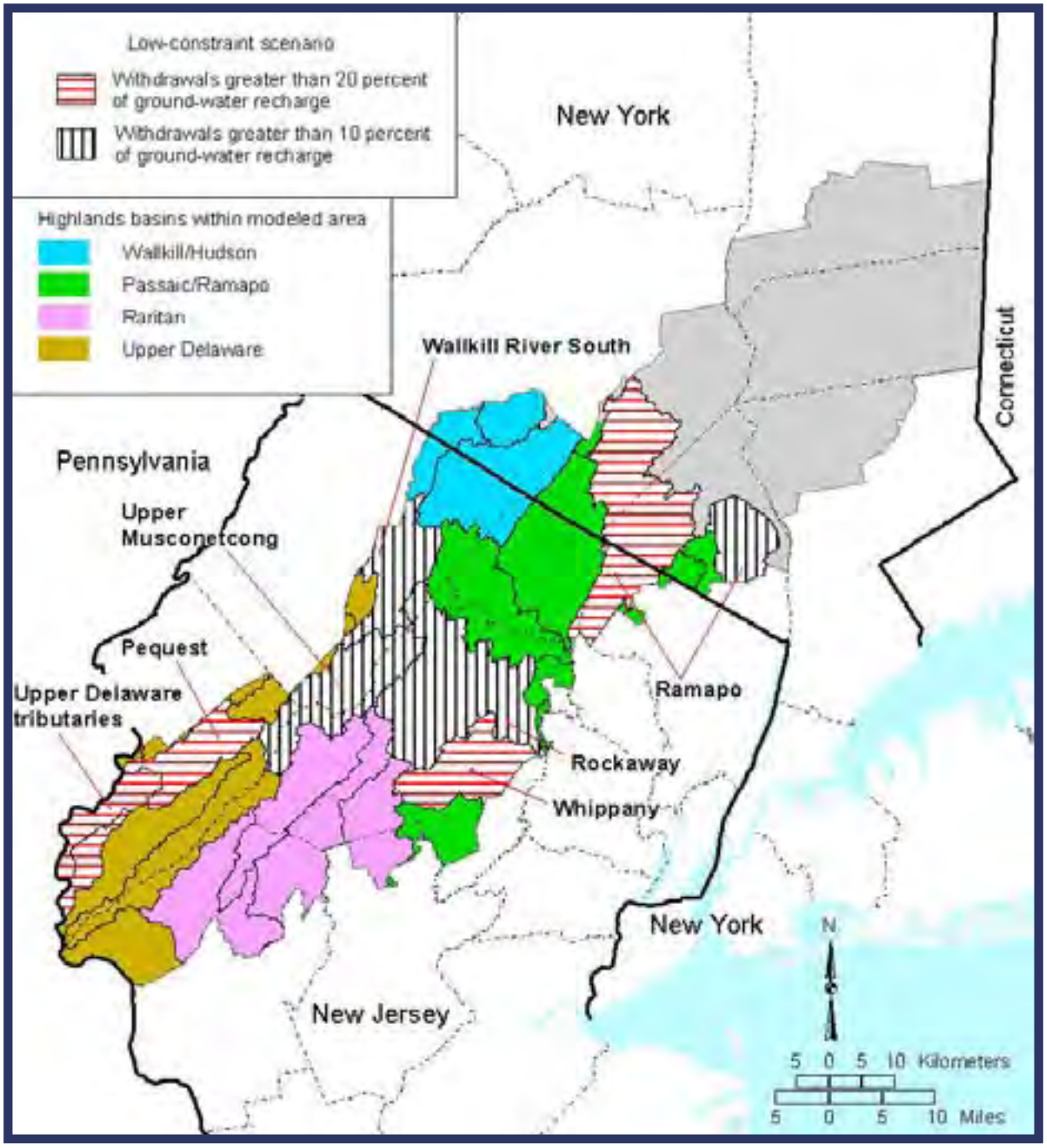


Figure 3-18. Sustainable water yield, low-constraint scenario. This map shows HUC 11 watersheds where ground water withdrawals exceeded 20 percent and 10 percent of the estimated ground water recharge under the low-constraint scenario of the build-out analysis. Thresholds of 20 percent and 10 percent of estimated recharge were used to determine watersheds most sensitive to increased ground water withdrawals under the low-constraint scenario. Hydrologic Unit Code 11 refers to subwatersheds with an average area of about 50 square miles. Compare Figure 3-17.

POSSIBLE CONSEQUENCES OF CHANGE: WATER RESOURCES

KEY FINDINGS:

- Water budget analysis of 182 Highlands subwatersheds shows that **as impervious surface cover increases, direct-runoff increases, baseflow decreases, and evapotranspiration decreases.**
- **The predicted rate of change in runoff, baseflow, and evapotranspiration increased significantly for subwatersheds with a projected increase of 15 percent or more impervious surface cover over conditions existing in 1995.**
- **Water budget calculations indicate a potential 50 percent or more increase in runoff, and a 10 percent or more decrease in baseflow, in subwatersheds with increases of impervious surface greater than 15 percent.**
- **The increase in impervious surface, as projected by the high- and low-constraint build-out scenarios, had a greater impact on changing Highlands water budgets than did the estimated increase in ground water withdrawals by the projected larger population.** However, both were predominant factors driving the change in water budgets.
- **Streamflow characteristics would be most affected in HUC 14 subwatersheds drained by the Wallkill, Lamington, Musconetcong, Pequest, Rockaway, Pequannock, Ramapo, and Pompton Rivers, and Lopatcong and Pohatcong Creeks**, owing to the increase in impervious surface cover and water withdrawals projected by the future development and population growth scenarios.
- **Loss of recharge water for aquifers, increased flooding during high-intensity rain storms, stressed ecosystems, decreased water-supply storage during droughts, and degraded water quality have been attributed to increases in impervious surface cover.** Increased monitoring of ground and surface water quality and quantity is warranted in areas expected to undergo significant development particularly in areas where there may be little existing data.
- **For 1995 conditions, ground water withdrawals exceeded 20 percent of ground water recharge only in the HUC 11 watersheds drained by the Whippany River.** Using the 10 percent threshold to represent sustainable yields, HUC 11 watersheds drained by the Ramapo River in New York and New Jersey, the upper Musconetcong River, the Pequest River, and tributaries of the upper Delaware River in Warren County, New Jersey—in addition to the Whippany—are the most sensitive to ground water withdrawals.
- **Based on the predicted population increase in the low-constraint scenario, and water use of 85 gallons per day per person, an estimated additional withdrawal of 52.4 million gallons per day was assumed from aquifers underlying the watersheds within the watershed model area.** Ground water withdrawals exceed 20 percent of aquifer recharge for this scenario in watersheds drained by the Ramapo, Whippany, and Pequest Rivers, upper Delaware tributaries, and Lopatcong Creek. Using a sustainable yield threshold of 10 percent, watersheds drained by the Rockaway and Upper Musconetcong Rivers are added to the watersheds previously mentioned.

RESOURCES AT RISK

To identify areas with high resource conservation value that are not presently protected from land conversion or development, results of this study were evaluated in two ways. First, the mapped results of the Conservation Values Assessment (Figure 2-25, page 77) were overlaid on maps of the existing network of publicly and privately owned lands that are in some type of "permanent" conservation protection, such as Federal, State, county and local parks, forests and wildlife management areas, watershed and agricultural lands in conservation easement, and nonprofit land trust holdings (Figure 2-17, page 64). Military and watershed management lands serve as quasi-open space but were considered unprotected.

Major clusters and large contiguous tracts that are unprotected and had values of 4 or 5 from the Conservation Values Assessment were identified as "conservation focal areas" that deserve special consideration for protection through land purchase, conservation easements or other means (Figure 3-19). These conservation focal areas include high value lands that serve to connect existing publicly or privately owned conservation lands into larger local networks of open space as well as provide regional scale connectivity along the northeast-southwest axis of the broader Highlands area. The letters in the following list correspond to the locations shown in Figure 3-19.

A. **Depot Hill/Pawling/West Mountain/Great Swamp** area in Putnam and Dutchess counties, New York. This forested upland and rich riverine wetlands complex anchors the northeast corner of the study area and continues north further into Dutchess County and northeast into Connecticut. This focal area was ranked highly in the Conservation Values Assessment due primarily to its value for water resources, productive forest land, and biodiversity.
B. **East Hudson Highlands** in Dutchess and Putnam counties, New York. There are large tracts of forested ridges and valleys that could be connected to provide a contiguous expanse between Hudson Highlands State Park on the west to Breakneck Ridge on the north to Clarence Fahnestock State Park on the east and along the Appalachian Trail corridor to Camp Smith in the south. This focal area was ranked highly due to its value for productive forest land, biodiversity, and recreation.
C. **Fort Defiance Hill and Canopus Valley**, Putnam and Westchester counties, New York. This corridor of upland ridges and forested valley connects Anthony's Nose and Camp Smith in the south with Clarence Fahnestock State Park in the north and includes the Appalachian National Scenic Trail corridor. This focal area was ranked highly due to its value for biodiversity and recreation.
D. **West end of New Croton Reservoir**, Westchester County, New York. There are large tracts of forested uplands (Dickerson Mountain, Salt Hill to Prickly Pear Hill) that would serve to connect Blue Mountain

Reservation on the west and Franklin D. Roosevelt State Park on the north and Teatown Lake Reserve in the south. This focal area was ranked highly due to its value for water resources and biodiversity, and secondarily for recreation.

E. **Tuxedo and Arden Farms** area, Orange County, New York. There are some major unprotected lands in high resource value zones adjacent to the existing Sterling Forest and Harriman State parks. This focal area was ranked highly due to its value for water resources, productive forest land, and biodiversity.

F. **Ramapo Mountains and Torne Valley**, Bergen County, New Jersey, and Rockland County, New York. There are some major unprotected lands in high resource value zones surrounding the Wanaque Reservoir that would connect existing State and county parks and forests in these two heavily utilized recreational areas. This focal area was ranked highly due to its value for water resources, biodiversity, and recreation.

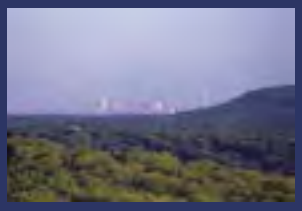
G. **Wyanokie and Farny Highlands**, Passaic and Bergen counties, New Jersey. There are some major unprotected lands in nearby Wanaque and Split Rock reservoirs that would connect existing State and county parks and forests in these two heavily utilized recreational areas. This focal area was ranked highly due to its value for water resources and recreation, and secondarily for biodiversity and forest land.

H. **Pequannock Watershed** area in Morris, Passaic, and Sussex counties, New Jersey. This critical watershed area serves as the core of the northern New Jersey Highlands and serves as a major hub connecting existing open space areas. Major gaps in conservation protection include the adjacent areas of Sparta Mountain and the Farny Highlands. This focal area was ranked highly due to its multiple values for water resources, forest land, biodiversity, and recreation.

I. **Sparta Mountain/Lubber's Run** area in Morris and Sussex counties, New Jersey. The wooded ridges of Sparta Mountain and Lubber's Run valley provide an important greenway corridor connecting Mahlon Dickerson Reservation in the north and Allamuchy Mountain State Park in the south. Major gaps in conservation protection include the nearby areas of Mase Mountain. This focal area was ranked highly due to its value for productive forest land, biodiversity, and recreation.

J. **Upper Pohatcong/Pequest** area in Warren County, New Jersey. These forested ridges and wetlands centered around the Pequest Wildlife Management Area serve as an important ground water recharge, wildlife habitat, and outdoor recreation area. This focal area was ranked highly due to its value for water resources and recreation and secondarily for its productive forest and farm land.

K. **Scott Mountain/Musconetcong Ridge** area in Warren and Hunterdon counties, New Jersey. These forested ridges and the neighboring productive farmland of the Delaware, Pohatcong, and Musconetcong valleys form a large contiguous area of high-quality rural landscape. This focal area was ranked highly due to its value for biodiversity and productive farmland, and secondarily for forest land and recreation.



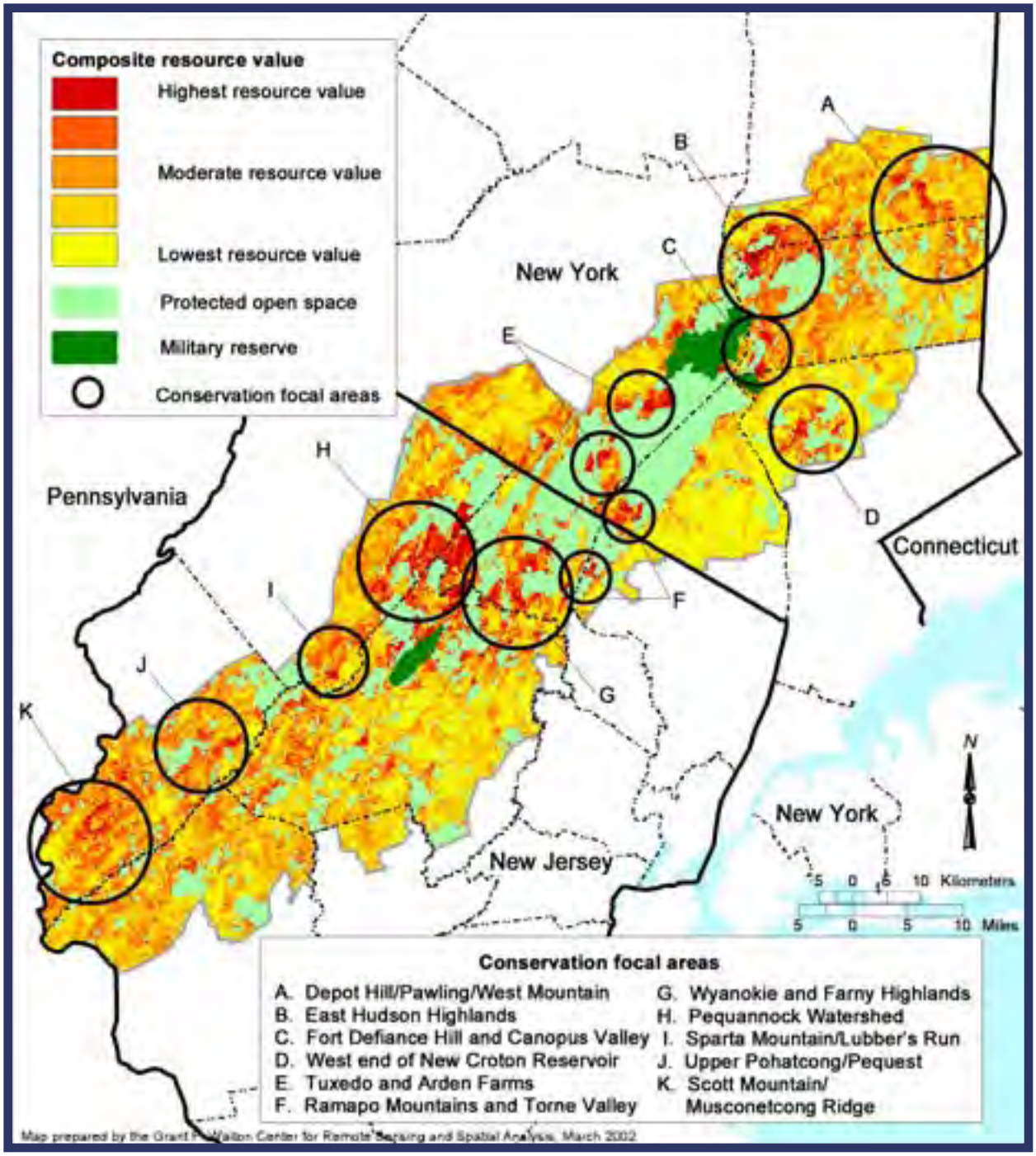


Figure 3-19. Conservation focal areas. Regional conservation focal areas are places in the Highlands where three conditions coincided: large contiguous tract or major cluster of land, a composite resource value of 4 or 5 from the Conservation Values Assessment, and absence of permanent protection.

RESOURCES AT RISK

Table 3-7 lists the acreages of protected and unprotected lands by resource and conservation value. Additional high value lands in need of protection that were not identified as conservation focal areas are scattered throughout the Highlands. Protecting only the higher ranked lands with a conservation value of 4 or 5 is not necessarily sufficient to achieve the stated goals of maintaining Highlands water resources, biodiversity, recreational opportunities, and productive farmland and forestland. Lower ranked lands should also receive consideration in future land use planning, and in natural resource and watershed management decisions. This analysis does not provide an exhaustive compilation of all possible conservation focal areas in the Highlands. The data presented are intended for regional analyses and discussion; however, local-level data will be accessible through an interactive mapping Web site being developed by Rutgers University's Center for Remote Sensing and Spatial Analysis as part of the New York – New Jersey Highlands Technical Report.

As a second means of evaluating conservation priorities, we used the results of the econometric analysis to highlight those areas with the highest probability of change in the short term and then cross-tabulated them with the results of the conservation values assessment (Figure 3-20). The results were reclassed into four categories:

Category*		Acres	Percent**
I	High likelihood of change, high conservation value	98,114	14.9
II	Low likelihood of change, high conservation value	338,462	51.4
III	High likelihood of change, low conservation value	86,531	13.1
IV	Low likelihood of change, low conservation value	135,786	20.6

*Lands given a value of 3 or more in the Conservation Values Assessment were classified as having a high conservation value.
**Percent figures are based on the area of land determined to be available for future development in the study area.

Approximately 100,000 acres of the New York – New Jersey Highlands region was categorized as having a high likelihood of change and higher conservation value, and represents those areas that should be considered priorities for future open space purchases and land use planning. These Category I lands might also be expected to have higher per acre land purchase or easement costs due to high development pressure. This higher land cost as well as smaller parcel sizes are expected to complicate open space protection efforts. A much larger area of approximately 340,000 acres was categorized low likelihood of change, high conservation value in the short term (Category II). Many of the large tracts of high conservation value lands identified as conservation focal areas fall into this category and therefore represent opportunities for open space protection at a potentially lower cost per acre.

Table 3-7. Protected and unprotected land in the Highlands, by resource and conservation value

Resource and Conservation Value	Protected land* Acres	Protected land* Percent of total	Unprotected land** Acres	Unprotected land** Percent of total	Total acres
Quality water supply					
1 Lowest value	10,367.56	5.31	184,849.17	94.69	**195,216.73**
2 Lower value	140,774.02	26.32	394,145.43	73.68	**534,919.45**
3 Medium value	71,587.05	23.50	233,074.62	76.50	**304,661.67**
4 Higher value	37,248.98	15.66	200,540.17	84.34	**237,789.15**
5 Highest value	51,642.76	36.07	91,538.45	63.93	**143,181.21**
Totals	**311,620.37**	--	**1,104,147.84**	--	**1,415,768.21**
Productive forest					
1 Lowest value	12,015.72	11.62	91,374.11	88.38	**103,389.83**
2 Lower value	22,994.42	13.52	147,054.43	86.48	**170,048.85**
3 Medium value	23,009.10	21.99	81,605.45	78.01	**104,614.55**
4 Higher value	97,719.23	46.10	114,259.11	53.90	**211,978.34**
5 Highest value	87,894.75	55.71	69,889.96	44.29	**157,784.71**
Totals	**243,633.22**	--	**504,183.06**	--	**747,816.28**
Contiguous interior forest habitat* **	**197,527.62**	47.46	**218,654.82**	52.54	**416,182.44**
Biodiversity					
1 Lowest value	25,136.74	15.10	141,362.92	84.90	**166,499.66**
2 Lower value	3,731.10	18.20	16,770.50	81.80	**20,501.60**
3 Medium value	33,158.94	15.77	177,136.77	84.23	**210,295.71**
4 Higher value	125,781.56	36.76	216,371.28	63.24	**342,152.84**
5 Highest value	89,321.63	44.91	109,566.60	55.09	**198,888.23**
Totals	**277,129.97**	--	**661,208.07**	--	**938,338.04**
Productive farmland					
1 Lowest value	2,129.42	9.15	21,149.66	90.85	**23,279.08**
2 Lower value	510.17	3.00	16,502.07	97.00	**17,012.24**
3 Medium value	4,347.13	8.57	46,375.14	91.43	**50,722.27**
4 Higher value	1,190.25	3.04	37,916.61	96.96	**39,106.86**
5 Highest value	9,586.07	90.19	1,042.81	9.81	**10,628.88**
Totals	**17,763.04**	--	**122,986.29**	--	**140,749.33**
Recreation					
1 Lowest value	597.35	0.39	152,149.70	99.61	**152,747.05**
2 Lower value	1,778.26	0.74	237,427.76	99.26	**239,206.02**
3 Medium value	2,291.99	0.61	372,797.39	99.39	**375,089.38**
4 Higher value	26,210.68	18.92	112,346.74	81.08	**138,557.42**
5 Highest value	280,132.73	83.06	57,138.34	16.94	**337,271.07**
Totals	**311,011.01**	--	**931,859.93**	--	**1,242,870.94**
Conservation values assessment					
1 Lowest value	745.24	0.24	313,449.57	99.76	**314,194.81**
2 Lower value	14,448.04	5.40	253,042.93	94.60	**267,490.97**
3 Medium value	39,367.51	13.37	255,042.92	86.63	**294,410.43**
4 Higher value	62,041.46	23.74	199,274.75	76.26	**261,316.21**
5 Highest value	195,073.06	69.50	85,614.10	30.50	**280,687.16**
Totals	**311,675.31**	--	**1,106,424.27**	--	**1,418,099.58**

*Protected land is presently in conservation ownership.
**Unprotected land is not permanently protected as open space or conservation land.
***Contiguous interior forest habitat was analyzed separately as a result of feedback received from the public and the work group for this study, due to the importance of interior forest in supporting habitat requirements for mammals and neotropical songbirds throughout the Highlands region.

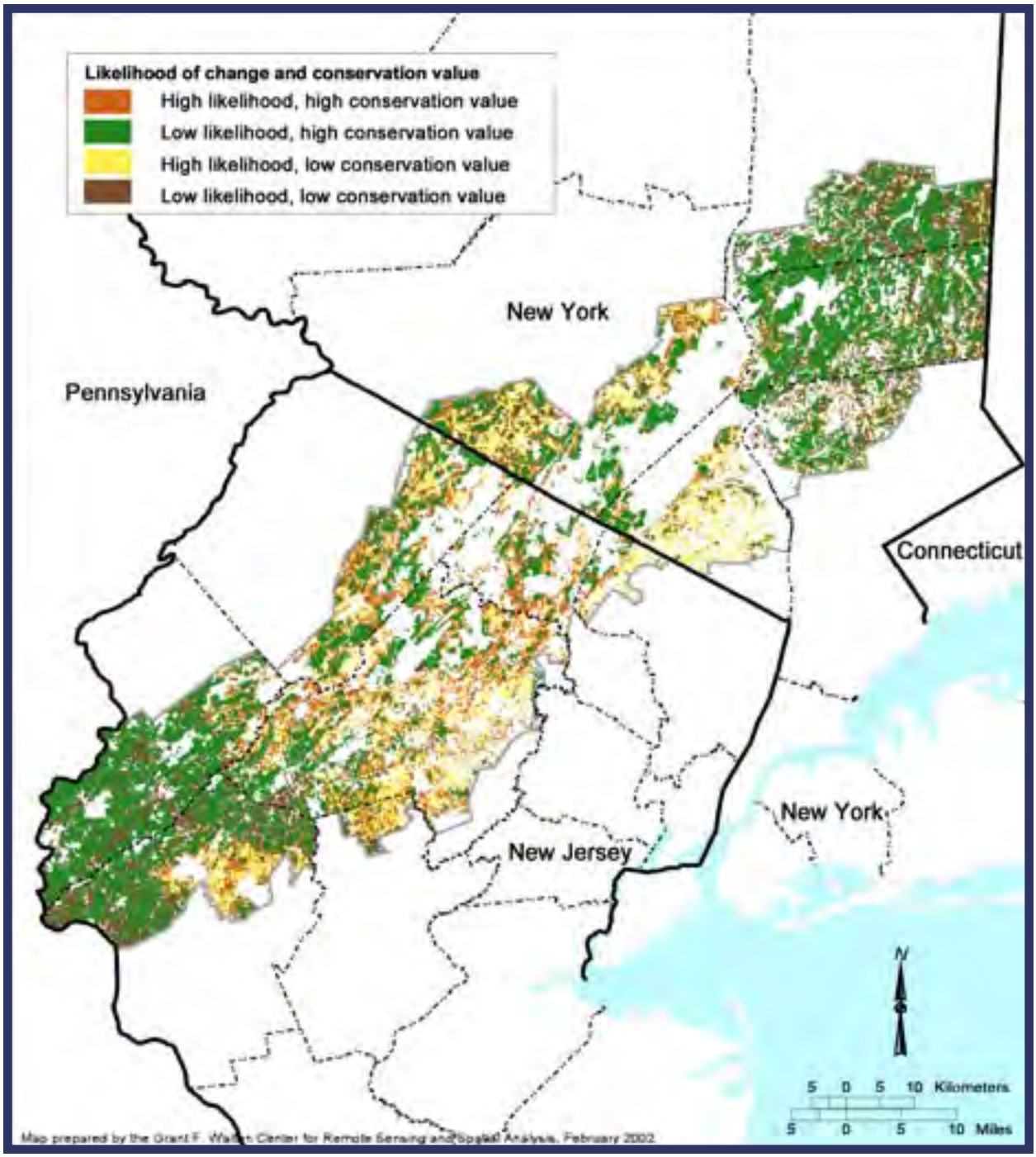

Likelihood of change and conservation value
High likelihood, high conservation value
Low likelihood, high conservation value
High likelihood, low conservation value
Low likelihood, low conservation value
New York
Pennsylvania
Connecticut
New York
New Jersey
N
5 0 5 10 Kilometers
5 0 5 10 Miles
Map prepared by the Grant F. Walton Center for Remote Sensing and Spatial Analysis, February 2002

Figure 3-20. Conservation priorities. Land that had a value of 3 or more in the Conservation Values Assessment and the highest probability of change in the Econometric Analysis are considered priorities for conservation.

Key Findings:

- Of the land that ranked higher (value of 4) and highest (value of 5) in the Conservation Values Assessment, **the following amounts were determined to be unprotected:**
  - **Water—77 percent of the land most valued** for water resources or 292,000 acres are unprotected. If all watershed purveyor lands are considered "protected," then this amount is lowered to 73 percent.
  - **Productive forest—50 percent of the land most valued** as productive forest or 184,000 acres are unprotected.
  - **Contiguous interior forest habitat—53 percent of all interior forests** or 219,000 acres are unprotected.
  - **Biodiversity—60 percent of the land most valued** for biodiversity or 326,000 acres are unprotected.
  - **Productive farmland—78 percent of the land most valued** as productive farmland or 39,000 acres are unprotected.
  - **Recreation—36 percent of the land most valued** for recreation or 169,500 acres are unprotected.
  - **Of the land that is highly valued for all five resources** (water, productive forest, biodiversity, productive farmland, and recreation) **53 percent** or 285,000 acres are unprotected.
- Combining the results of the Conservation Values Assessment and the Econometric Analysis shows that **15 percent** or 98,000 acres **of the New York – New Jersey Highlands has a high conservation value and a high likelihood of change.**

SECTION 3 REFERENCES

Andrle, Robert F.; Carroll, Janet R., eds. 1988. The atlas of breeding birds in New York State. Ithaca, NY: Cornell University Press; 551 p.

Arnold, Chester; Gibbons, Jim. 1996. Impervious surface coverage. American Planning Association Journal 62: 243-258.

New Jersey Department of Environmental Protection and Energy. 1992. New Jersey Statewide water supply master plan Task 2 report: Water supply baseline data development and analyses. Trenton, NJ; 200 p.

New Jersey Department of Environmental Protection. 1996. New Jersey Statewide water supply plan—The vital resource. Trenton: Office of Environmental Planning; 173 p.

New Jersey Water Supply Authority. 2000. Water budget in the Raritan River Basin. A technical report for the Raritan Basin watershed management project; 21 p. http://www.raritanbasin.org/technical_reports.htm (8 August 2002).

Schueler, T.R. 1998. Rapid watershed planning handbook—A comprehensive guide for managing urbanizing watersheds. Ellicott City, MD: Center for Watershed Protection.

U.S. Census Bureau. 2001. American FactFinder. http://factfinder.census.gov/servlet/BasicFactsServlet. (23 August 2002).

U.S. Fish and Wildlife Service. 2000. National Wetlands Inventory. [Database]. http://www.nwi.fws.gov. (23 August 2002).

Walsh, J.; Elia, V.; Kane, R.; Halliwell, T. 1999. Birds of New Jersey. Cape May: New Jersey Audubon Society; 704 p.

Section 4 Resource Summary and Conservation Strategies

Photograph by George M. Aronson

"There are no easy solutions to the challenges of sustaining America's forests and communities. The job is too big for any one group or agency... in partnership we can ensure their future."

Dale Bosworth, Chief, USDA Forest Service

Section 4 Resource Summary and Conservation Strategies

This section presents resource information from Section 2, conservation focal areas and priorities from Section 3, the land management framework and stewardship goals for the Highlands, and strategies for increasing protection of resources.

Resource Condition

The natural resources in the Highlands make it a region of national significance. Approximately 40 percent of the New York – New Jersey Highlands—540,000 acres—are considered to have significant overall conservation values. But less than half of that land is currently protected. Moreover, other lands that may not be highly ranked on an overall basis are still critical to the sustainability of the specific resource values that people currently enjoy. For example, about half the large interior forests—approximately 200,000 acres—that both define the Highlands landscape and protect many of its highest quality watersheds and rare ecosystems are not protected and are vulnerable to further fragmentation and urbanization (Table 3-7, page 133).

The quality of ecosystem services and benefits directly affect human health and well-being. When ecosystems are degraded, the services and benefits also are degraded. Benefits affected are water quality and quantity; habitat viability; resilience of the ecosystem to withstand native pests and invasive exotic species; recreational opportunities; and the productivity and management opportunities of forest and agricultural lands.

Through the use of a Conservation Value Assessment model in this study, significant habitats and ecosystems were identified for conservation and protection. This assessment also identified the following existing conditions, projected changes, and environmental risks that would occur without additional conservation measures:

Water:

About 64 percent of the highest value water resource lands were identified as unprotected areas deserving further protection.

Projected changes: Increased dependence on Highlands water; increased storm runoff, decreased infiltration, and decreased stream baseflow and ground water availability.

Potential risks: Less water for a growing population; additional water treatment costs.

Productive Forests:

About 44 percent of the most productive forest lands were identified as unprotected areas deserving further protection.

Projected changes: Conversion of forest land to nonforestry uses, decreased parcel size, changed landowner objectives, lost productive forest land.

Potential risks: Loss of timber resources, greater restrictions on forest management operations.

Biodiversity:

Exactly 55 percent of the lands ranked highest for biodiversity were identified as unprotected areas deserving further protection.

Projected changes: Increased habitat loss, increased habitat fragmentation, increased number of exotic species.

Potential risks: Local extirpation of threatened and endangered species; loss of regional biodiversity.

Farms:

About 10 percent of the highest value productive farmlands were identified as unprotected areas deserving further protection.

Projected changes: Conversion of farm land to nonfarm uses, decreased parcel size, changed landowner objectives, lost productive farmland.

Potential risks: Loss of prime farm soils, greater restrictions on farm management operations.

Recreation:

About 17 percent of the highest value recreation lands are identified as unprotected areas deserving further protection.

Projected changes: Decreased recreational opportunities.

Potential risks: Fewer recreational areas, fewer recreational access points, decreased recreational opportunities, and diminished scenic beauty.

While the significance of Highlands natural and cultural resources are perhaps most evident when viewed from a regional perspective, stewardship of these resources is more likely to be the result of decisions made at the local level. Whether management considerations are made by public or private landowners or through local government's land-use planning and regulatory powers, the thousands of individual decisions made every day across the Highlands are the largest determinant of the future of this landscape.

Traditionally, these decisions first reflect local and site-specific concerns. But, as shown by the Conservation Values Assessment in Section 2 and future change analyses in Section 3, cumulatively, these decisions have a regional effect on water, biodiversity, and recreational resources. Reconciling the gap between local decisions and regional effects is a critical challenge if the resources of the Highlands are to be sustained for future generations.

The analysis of current trends underscores the potential situation faced by the residents of the Highlands and others who also care about the future of its natural resources. About 100,000 acres (out of 285,000 acres) of these highest value areas have a high likelihood of being changed; 340,000 additional acres have high conservation value but a lower likelihood of being changed. Using current and projected population growth, the Highlands population could increase from 1.7 million to 2 million people in the next several decades, a growth rate of 26 to 48 percent from 2000 census figures. Based on the changes since 1990, more than 5,000 acres of forests, wetlands, and grasslands in the Highlands are affected each year—a rate that has accelerated since 1997.

The analyses in Section 3 described the likely effects caused by land use change. Perhaps most important are the expected effects on water resources. The number of watersheds in the Highlands likely to have high quality surface waters (less than 15 percent impervious cover) could be reduced by half in the next several decades. The number of watersheds with the exceptional water quality needed to sustain wild trout populations (less than 10 percent impervious cover) could be reduced by more than 75 percent. Expected ground water withdrawals are likely to exceed local supply in a number of the Highlands watersheds, including the Ramapo, Whippany, Pequest, Upper Delaware, and Lopatcong. The Rockaways and Upper Musconetcong basins could also show similar shortages.

Land Stewardship in the Highlands

The Highlands region is a complex mix of private and public ownerships. Within each ownership group, a range of objectives, interests, and concerns exists, which poses considerable challenges and opportunities to conserve and protect critical resources.

Land Management Challenges

Even in a static ownership environment, the diversity of private ownership in the Highlands would be a complex picture. In fact, we expect private landownership will become increasingly complicated, posing additional challenges to the stewardship of natural resources. In the future, an increasing percentage of the Highlands will probably be owned and managed by more people, which would further parcelize existing ownerships and fragment existing forest cover. Based on the most recent land ownership survey, 84 percent of the forest land in the greater Highlands was privately owned. The number of acres owned has steadily declined over the past decades to less than 12 acres per owner. Likewise, more than 50 percent of the Highlands forest tracts are smaller than 10 acres. At this tract size, forest management becomes economically prohibitive, and there is insufficient contiguous forest to sustain native species that inhabit the forest interior.

For farmland, ownership patterns are similar. In addition, with an increase of residential and recreation/vacation homes adjacent to agricultural lands, farming activities become increasingly difficult as new neighbors complain about the smells and sounds of an operating farm.

Another problem is that landowners have little or no incentive to provide public benefits, such as clean water and wildlife and fish habitat. In many cases, tax laws and local ordinances actually serve as a disincentive for continued stewardship or even continued ownership of large contiguous blocks of land. For example, minimum lot size for residential housing has increased; however, local laws and zoning ordinances still encourage land subdivision and fragmentation of large tracts of forest cover.

Many of the same concerns, challenges, and constraints associated with multiple owners of private land occur with public land. Many public entities are involved, with diverse management objectives, different levels of funding for management and maintenance, and a mix of missions and authorities that may have competing objectives.

Three significant challenges have slowed progress towards regional and coordinated open space planning in the Highlands:

- Inadequate coordination among States, counties, and municipalities;
- The lack of a consistent regional view of environmental issues among Highlands decisionmakers; and
- Insufficient financial and technical resources available to natural resources agencies and private landowners to manage lands and pursue conservation strategies, including acquisition of lands.

Land Stewardship Opportunities

The parcelization of the landscape highlights the importance of those unfragmented, high value areas, including forests, that still remain. The analyses in Section 3 identified 11 such areas, comprising about 86,000 acres of the Highlands region, as Conservation Focal Areas (Figure 3-19, page 131):

A. Depot Hill/Pawling/West Mountain;
B. East Hudson Highlands;
C. Ft. Defiance Hill and Canopus Valley;
D. West end of New Croton Reservoir;
E. Tuxedo and Arden Farms area;
F. Ramapo Mountains and Torne Valley;
G. Wyanokie and Farny Highlands;
H. Pequannock Watershed;
I. Sparta Mountain/Lubber's Run;
J. Upper Pohatcong/Pequest area; and
K. Scott Mountain/Musconetcong Ridge area.

Another means of identifying conservation priorities was to use the results of the econometric model of land use change (Section 3) to highlight those areas with the highest probability of change in the future and then to cross-tabulate those areas with the results of the Conservation Values Assessment in Section 2. Approximately 15 percent, or 100,000 acres of the New York – New Jersey Highlands region, had a high conservation value and a high likelihood of change. This analysis is useful as a tool for open-space purchase and land-use planning. Assumptions made during the analysis may change over time.

The areas identified in these analyses offer the best opportunity to sustain the Highlands resources and to ensure the quality of life for people who depend on benefits and services provided by those resources. The identification of these areas will help to inform decisionmakers of the resources that need to be protected, managed, or restored.

In addition, conservation opportunities need to include concerted complementary action throughout the region. One example is creating and maintaining forested riparian buffers. Riparian buffer areas play a crucial role in protecting aquatic systems and water quality. Development in these sensitive areas increased dramatically between 1984 and 2000. The future of remaining riparian buffers in the Highlands is uncertain. Establishing a minimum forested riparian buffer width of 150 feet (Section 3, Criteria for the High-Constraint Scenario) will reduce development in this sensitive area despite a large increase in population. Protection and creation of buffers throughout the region can have a ripple effect—both in terms of additional on-the-ground improvement, and in terms of broader education and awareness of natural resource issues and solutions.

The stewardship capability of all landowners will determine the amount and condition of natural resources found in the Highlands. Landowners' awareness, commitment, and ability to protect and manage resources are critical to sustaining the derived ecosystem benefits. One program that serves forest landowners is the Forest Stewardship Program of the USDA Forest Service. The program provides technical expertise to nonindustrial private forest landowners to ensure that environmental and economic resource management principles are applied on their forest lands. Only a relatively small percent of private forest land (16,000 acres) is enrolled in the program. Similarly, the USDA Natural Resources Conservation Service has two programs: the Conservation Reserve Program (CRP) and the Environmental Quality Incentives Program (EQIP) to serve farmers and help protect natural resources.

The 2002 Farm Bill and the associated Conservation and Forestry Title programs, including a new Forest Land Enhancement Program, will provide funding to land owners for stewardship activities, and offers the opportunity for increased protection and conservation of natural resources in the region.

For more information on assistance programs for various resources, see Appendix I.

LAND MANAGEMENT FRAMEWORK

Because land in the Highlands is owned by many private and public interests, land and resource management and planning involves a complex network of heterogeneous private, local, county, State, and Federal organizations. In New York, there is less focus on the Highlands as an entity, and more attention on the area of the Highlands in the Hudson River Valley, also known as the Hudson Highlands. In New Jersey, the Highlands physiographic province has been recognized as an area of national significance by Federal, State, county, and nonprofit organizations.

The following section briefly summarizes ways that several public and private organizations have protected the natural resources of the Highlands and outlines potential future roles for these organizations. Appendix J provides a list of conservation activities and successes in the Highlands region.

EXISTING PARTNER ROLES

The Palisades Interstate Park Commission (PIPC) was established by bi-State compact and approved by the U.S. Congress more than 60 years ago. This bi-State agency could participate in land acquisition and land management within the New York – New Jersey Highlands region. In 1995, the New

Jersey State legislature expanded the jurisdiction of PIPC. In 1997, PIPC was directly involved in purchase of portions of Sterling Forest in New York, and is responsible for management of the Sterling Forest State Park.

The need to protect critical open space parcels in the Highlands has also been documented in a number of important Federal and State studies including the New Jersey Development and Redevelopment Plan, the New York State Open Space Plan, and the U.S. Fish and Wildlife Service's New York Bight Restoration Study. (*Note*: "Bight" in this context refers to the ocean area extending approximately 100 miles offshore from the Sandy Hook-Rockaway Point Transect to the Continental Slope.)

Specifically, the New Jersey State Development and Redevelopment Plan recognizes the Highlands region as the first Special Resource Area in New Jersey. According to the State Plan, a Special Resource Area is a region with unique characteristics or resources of Statewide importance that are essential to the sustained well-being and function of its own region and other regions or systems—environmental, economic, and social—and to the quality of life for future generations. The State Plan recommends some planning and implementation strategies in the Highlands.

The New York State Department of Environmental Conservation's Draft Open Space Plan (New York State Department of Environmental Conservation 2001) identifies the Highlands as a unique physiographic region. This "unique area" category provides for the inclusion of several types of conservation of natural resources that do not fit neatly under the "significant ecological area" category. These areas do, however, meet the definition of significant ecological area, notably lands of natural beauty, of geological significance, and some wilderness character lands. The plan recommends developing a greenway corridor comprised of State parks, Department of Environmental Conservation forests, and other lands that span the length of the New York Highlands. In addition, the biodiversity assessment manual for the Hudson River estuary corridor (Kiviat and Stevens 2001) cites the need for additional inventory work to prevent continued conversion and fragmentation of Highlands area forests and wetlands. In addition, State watershed level assessment and planning at the county level in both New York and New Jersey provide a more regional perspective and foster cooperative action.

Demonstration of these approaches and others through Land Conservation Projects and pilot programs offer opportunities to showcase the potential for collaborative land-use decisionmaking and natural resource management (Appendix K).

Potential Partner Roles

Because the Highlands and their resources are nationally significant, the Federal government has an important responsibility to protect this landscape. One way to meet these challenges is through a partnership approach that involves Federal, State, and local governments, nongovernmental organizations, and individual citizens. Appendix I provides detailed information on Federal and State assistance programs for private landowners and organizations and how they might be effective in the Highlands region. As previously stated, often these programs work independently of each other. By acting in a coordinated manner, however, these agencies could provide complementary and shared approaches and avoid duplication of efforts in protecting and conserving the valuable resources of the Highlands.

USDA Forest Service

The USDA Forest Service envisions its role in the Highlands as one of convener, catalyst, and coordinator in supporting and implementing resource protection and management.

The Forest Service can act as a convener by bringing together various interests from across the Highlands region for purposes of education, stewardship, research, and coordination of conservation actions. The 1992 Highlands regional study and this 2002 update are part of the process of increasing the shared knowledge of natural resources, providing better and more consistent information across the entire Highlands region, and creating public forums to discuss and use these data. The Forest Service can continue to serve a Highlands-wide role in the future by establishing an on-going Highlands resource assessment process to initiate and coordinate studies in the Highlands and to create forums, including local compacts and bi-State roundtables, to help coordinate the use of natural resources information in land-use decisionmaking.

The Forest Service can also be a catalyst for specific conservation actions through its Cooperative Forestry Programs and by providing technical assistance to land use planners and natural resource managers in cooperation with the New York State Department of Environmental Conservation and New Jersey's Department of Environmental Protection. Existing Federal programs such as Urban and Community Forestry, Forest Legacy, and Forest Stewardship are ways in which the Forest Service already provides financial and technical assistance through the State agencies. The local Land Conservation Projects (Appendix K) funded as part of this study update serve as additional examples of support for local conservation actions.

The Forest Service can further help to implement these conservation strategies by acting as a coordinator among Federal agencies in protecting priority open space parcels, while providing tools for effective stewardship of existing lands.

OTHER FEDERAL PARTNERS

Several other Federal agencies have natural resource protection and conservation programs that can make significant contributions to the management of the Highlands.

Federal partners, such as USDA Natural Resources Conservation Service; the Department of the Interior's Fish and Wildlife Service; U.S. Geological Survey; National Park Service; the USDA Cooperative State Research, Education, and Extension Service; and the U.S. Environmental Protection Agency have programs that can be implemented or expanded in the Highlands region to protect priority open space areas, work with public and private landowners on the proper stewardship of their lands, identify lands for open space acquisition, improve local land-use planning practices, and encourage regional planning for data management and open space protection.

STATE PARTNERS

State partners, such as the New Jersey Department of Environmental Protection and New York State Department of Environmental Conservation, have several programs that can be implemented or expanded in the Highlands region. State partner agencies work closely with regional, county, and watershed-level entities in natural resource protection and planning. In New Jersey, the Department of Environmental Protection funds planning activities for watershed management areas. Planning activities in several Highlands watersheds include education and outreach, watershed characterization and assessment, and open space and farmland preservation. In New York, the Department of Environmental Conservation has assisted in numerous land acquisitions in the Highlands region, funded by the Clean Water/Clean Air Bond Act and the Environmental Protection Fund.

LOCAL GOVERNMENT PARTNERS

While the significance of Highlands natural and cultural resources are perhaps most evident when viewed from a regional perspective, stewardship of these resources is more likely to be the result of decisions made at the local level. Land use planning and zoning are local governments' primary activities for protecting important natural resources and lands. Effective open space protection usually involves an appropriate mix of planning, regulation, and acquisition. Planning identifies important natural resources, protected lands, and linkages between those spaces. Regulation uses local ordinances and State laws to protect important areas, such as steep slopes, stream corridors, and wetlands. Finally, land acquisition involves obtaining important lands through purchase or donation, either through acquisition of full fee title, or purchase of development rights through a conservation easement.

Land acquisition activities at the local level have been successful in almost 200 municipalities across New Jersey through the establishment of local open space taxes. Local open space committees work with land trusts, environmental organizations, elected officials, planning boards, and citizens to protect open space. In Morris County, the Open Space Farmland Preservation Trust Fund has helped in the acquisition of approximately 7,000 acres in the Highlands since 1993. In Sussex County, the Farmland Preservation program protected the first farm—121 acres in Green and Andover Townships—in 1990. To date, New Jersey's Farmland Preservation Program has permanently preserved 625 farms totaling over 85,000 acres.

The master planning process is another way for local governments to identify and protect important natural resources. The residents of Philipstown (Putnam County), New York are in the midst of a 2-year comprehensive planning process, and the town has focused attention on protecting important open space parcels. A grant from the USDA Forest Service has helped to ensure that the comprehensive resource information presented in the New York – New Jersey Highlands Regional Study: 2002 Update as well as other data from a variety of partners will be used to inform Philipstown's comprehensive plan and zoning ordinance update (Appendix K).

ORGANIZATIONS AND CITIZENS

Private, nongovernmental, and citizen organizations can play an important role in the protection of open space lands. Private organizations such as corporations and foundations can provide financial support to aid in land acquisition and planning activities. Nongovernmental organizations such as housing, economic development, and environmental groups can provide information to citizens on important natural resource issues that might not be fully addressed by Federal, State, or local government agencies. Also, land trusts and river basin organizations are important nonprofit groups that help acquire forests and farmlands by working with public officials to develop applications for State and county open space acquisition programs. Organizations such as the Trust for Public Land, Passaic River Coalition, New Jersey Conservation Foundation, Orange County Land Trust, and Scenic Hudson have been instrumental in fostering the relationships between property owners and public officials in several Highlands communities for land protection.

The individual citizen role can also be powerful in protecting natural resources. Citizens can work on a grassroots level to garner support for an issue and can be active in neighborhood associations and community boards, as well as gathering support for an issue at the local, county, State, or Federal level. Other examples include grassroots groups such as environmental commissions and homeowners associations; organizations such as watershed associations and soil and water districts; and regional entities such as river basin commissions and environmental

coalitions. Whether management considerations are made by public or private landowners or through local governments' land-use planning and regulatory powers, the thousands of individual decisions made every day across the Highlands significantly influence the future of this landscape.

The growth of public and private partnerships has significantly led to the protection of many areas in the Highlands; however, many challenges still exist. To address these challenges, strategies to conserve and protect areas essential to maintaining the quality of life of millions who use and depend on the Highlands' natural resources are outlined below.

Conservation Goals and Strategies

Stewardship Goals

The 1992 Highlands Study report set out five goals that are still considered vital for the long-term stewardship of the Highlands:

1. Manage future growth that is compatible with the region's ecological constraints;
2. Maintain an adequate surface and ground water supply that meets the needs of local and downstream users;
3. Conserve contiguous forests using management practices that are consistent with private property rights and regional resources;
4. Provide appropriate recreational opportunities; and
5. Promote economic prosperity that is compatible with goals 1-4.

Success in meeting the goals for the Highlands and implementing conservation strategies is a shared responsibility. All levels of government, landowners, businesses, citizens, and conservation organizations must be involved to ensure the goals are achieved.

Partnership Model

The House Conference Report for Fiscal Year 2002 recommended that the approach that has been used to protect Sterling Forest be considered as a model for the rest of the Highlands (Appendix A). The Sterling Forest partnership is nurtured through existing authorities and programs at the Federal, State, and local levels, and leadership at each of these levels brings the partners together. Participation by nongovernmental organizations and private citizens is vital to this partnership.

Through this partnership in Sterling Forest, nearly 20,000 acres have been protected since 1990:

- In 1990, 2,000 acres—all within New Jersey—were purchased from the Sterling Forest Corporation by Passaic County with $9.2 million from the New Jersey Green Acres Program.
- In 1998, 15,280 acres were purchased from a Swiss investment group for $55 million. Congress provided $17.5 million (Federal Land and Water Conservation Fund); New York provided $16 million; New Jersey provided $10 million; and various foundations and the public donated $11.5 million. Major private contributions included $2.5 million from the Open Space Institute; $2.5 million from Scenic Hudson; $1 million from the Lila Acheson and DeWitt Wallace Fund for the Hudson Highlands and the Victoria Foundation Fund; and $5 million from the Doris Duke Charitable Foundation.
- In 2000, 1,350 acres were purchased from Sterling Forest Corporation for $7.89 million. The Federal government contributed $2 million through the USDA Forest Service's Forest Legacy Program; New York contributed $4 million; and New Jersey contributed $1 million. The Palisades Interstate Park Commission, North Jersey District Water Supply Commission, foundations, and private individuals contributed $890,000.
- Later in 2000, 659 acres were purchased from New York University for $860,000. New York contributed $360,000; the Trust for Public Land contributed $250,000; and the Palisades Interstate Park Commission contributed $250,000.
- Also in 2000, 209 acres were purchased from the B. Sears Hunter and Lawrence W. Copans Trust for $610,000 using funds from New York.

As of September 2002, the total acreage in Sterling Forest was 17,988 acres in New York and 2,000 acres in New Jersey.

CONSERVATION STRATEGIES

Eight strategies have been identified to improve the stewardship of the Highlands' resources. Additional ideas were suggested during the public comment period and at the public listening sessions. These ideas were considered during the development of the conservation strategies, but some were not deemed practical or viable means for protecting the Highlands due to land ownership patterns and established policies for land-use decisionmaking. Such ideas included the establishment of a Highlands National Forest and the creation of a council or commission to guide natural resource decisionmaking in the Highlands. While these suggestions are not specifically included, the eight strategies do provide an array of choices and associated actions that should address most of the concerns raised through public comments.

CONSERVATION GOALS AND STRATEGIES

The following strategies are offered with the understanding that conservation of the rich and valuable landscape will be accomplished only through a broad partnership that brings together complementary strengths, information, and resources. (Numbers in parentheses tie each strategy to the five goals for the Highlands.)

a. **Inform people about Highlands resource values.** A better understanding of the regional value of Highlands resources is essential to build a basis for protection and management. (Goals 1-5)

b. **Provide consistent and updated information on Highlands resources for decisionmakers.** This study is a first step towards ensuring that decisionmakers are answering questions based on the best available data. (Goals 1-5)

c. **Promote stewardship and protect landowner equity in private lands.** The majority of land in the Highlands is privately owned, and will probably continue to be so in the future. Incentives and technical assistance can help landowners ensure that forest and farmland continue to provide essential ecosystem benefits. (Goals 2-5)

d. **Provide current and new information on management issues and practices on public and private lands.** The long-term stewardship of Highlands resources requires continued care of its land and water. The availability of science based resource management techniques, and most importantly, the dissemination of that knowledge to land managers is critical. (Goals 2-4)

e. **Acquire easements and land for conservation purposes or compensate private landowners and local government for conservation of natural resources.** The use of public and private funds for acquisition is the most direct way of ensuring that Highlands resources identified in the study are protected for future generations. Such acquisitions are often a savings in community infrastructure costs but in some towns may result in a reduction of needed revenue for services. The effects of such acquisitions on local tax revenues need to be evaluated on a case-by-case basis. (Goals 2-4)

f. **Improve State and local land use planning practices as a means of conserving Highlands resources**. The build-out and econometric analyses have indicated that the current patterns of growth will continue to change Highlands resources. Local decisionmaking, in particular, will influence form and substance of this change and the practices that are available to protect and manage Highlands resources. (Goals 1 and 5)

g. **Improve and coordinate regional, interstate and intrastate conservation efforts**. Comprehensive conservation measures that span local and even State political boundaries may be needed for the long-term sustainability of regionally important resources. Such cooperation does not come naturally, so it must be encouraged and sustained. (Goals 1-4)

h. **Use indicators to measure and monitor Highlands resource change.** Indicators based on the Highlands study and other environmental work can enable people to track changes in the environment and inform decisionmakers on the impacts and results of actions implemented. (Goals 1-5)

Actions and challenges associated with each strategy, and potential measures of accomplishment or environmental change are summarized in Table 4-1. These strategies are offered to stimulate public discussion, improve decisionmaking, and ensure resource availability in the Highlands for generations to come.

CONSERVATION GOALS AND STRATEGIES

Table 4-1. Conservation strategies for the Highlands

Actions may include:	Challenges may include:	Measures of accomplishment or environmental change:
a. Inform people about Highlands resource values.		
Provide public forums and educational materials for the Highlands. Tailor workshops for officials, planning boards, and conservation committees to promote the value of resources and the tools available to protect and manage these resources. Establish and maintain a set of descriptions that illustrate the ecological, social, and economic qualities of the Highlands.	Establishing an identity for the Highlands among named geographic areas. Reaching agreement on the relative importance of resources. Developing and defining meaningful descriptions. Conveying complex ecological information.	Ongoing public forums to identify changing issues are established. Environmental workshops are convened. Highlands specific descriptors are used by people in public discussion and publications.
b. Provide consistent and updated information on Highlands resources for decisionmakers.		
Build and maintain a regional information system and, where needed, improve the Highlands Regional study. Make the study available to Federal, State, and local officials, and others; and facilitate its use. Prepare and distribute technical guides, carrying capacity studies, ecological unit maps and descriptions of unit capabilities, and other applied information.	Enabling agencies and organizations to share data. Achieving adequate distribution and utility (specificity) of data. Meeting the costs associated with information systems and outreach. Completing ecological mapping at a local scale in a timely manner.	A regional information system is established. Assessment data is available, and information systems are accessible. Landowners and decisionmakers use information in planning and setting resource objectives. Training in data access and data use is provided. Ecological unit maps and descriptions are used at county and municipal levels.
c. Promote stewardship and protect landowner equity in private lands.		
Create a Highlands-specific approach for natural resource management on private forests and farmlands that focuses on the highest conservation value areas. Reduce the tax burden on private forests and farmlands by promoting existing programs and qualifying properties managed for water, wildlife, or recreation, in addition to commodity production. Promote consistent and appropriate timber harvest and resource protection ordinances.	Getting landowners to adopt management practices. Accommodating changes in ownership patterns and land tenure.	An approach to land management that addresses issues commonly faced by Highlands residents, especially forest and farmland owners, is established. Assistance programs for private lands are expanded and implemented in priority areas. Acreage of land with conservation and stewardship plans increases. Tax laws are revised to allow credit to landowners who provide water, wildlife, and recreation opportunities on their land. A Highlands-specific timber harvest ordinance is developed.
d. Provide current and new information on management issues and practices on public and private lands.		
Develop or disseminate the latest information on management issues including invasive species, forest fragmentation, deer management, critical headwater areas, riparian corridors, drinking water supplies, nutrient pollution, and soil erosion. Establish demonstration areas and pilot projects to test and showcase management practices on public and private lands.	Gaining acceptance of research results and findings. Overcoming the uncertainty of land managers to adopt new techniques and practices. Gaining public acceptance of the need for land management to provide sustainable and healthy landscapes.	Local and regional plans adopt procedures to protect key Highland resource values. Plans are readily available to the public and are followed. Conservation demonstration areas are established. Management techniques and practices are adopted: (1) the deer herd is reduced to established carrying capacity to protect biological diversity, and (2) functioning riparian buffers are established and maintained.

Table 4-1. Conservation strategies for the Highlands *(continued)*

Actions may include:	Challenges may include:	Measures of accomplishment or environmental change:
e. Acquire easements and land for conservation purposes / compensate private landowners and local government for conservation of natural resources.		
Prioritize lands for acquisition through an interstate forum of public and private partners, based on the information in this report. Provide funding to acquire prioritized lands through a partnership of Federal, State, and local sources. Utilize fee simple and conservation easement acquisitions to protect land, as appropriate. Create opportunities for public and private partners to review acquisitions and priorities for use of Federal and non-Federal funding.	Reaching agreement on priorities for land acquisition. Funding acquisitions estimated to cost from $500 million to $1.5 billion. Providing appropriate compensation to communities for additional public landownership. Increase Federal funding for the purchase of land and easements. Evaluate the cost or savings of land acquisition and provide consistent mechanisms for compensating localities for documented losses of revenue.	Lands for conservation and protection on a regional scale are prioritized. Funding sources for purchasing land, easements, and development rights are secured.
f. Improve State and local land use planning practices as a means of conserving Highlands resources.		
Work with State and local agencies and officials to incorporate Highlands assessment data into capital improvement, master planning, and environmental constraints. Focus technical and financial assistance in high priority areas. Use performance-based practices to protect resources and address issues related to sewage treatment, drinking water availability, large-lot zoning, and compact development.	Ensuring that decisions are made in a regional context. Changing traditional land management or zoning and land-use planning practices.	Highlands-specific issues are addressed in State and local land use practices and master plans. New developments are designed to protect open space and water quality.
g. Improve and coordinate regional, interstate and intrastate conservation efforts.		
Foster ways and means to coordinate and share decisionmaking among States and municipalities. Establish a public and private roundtable on protection, conservation, and management of the Highlands region. Continue the Forest Service leadership role in land management in the Highlands and in implementing these strategies.	Working within the complexity of the existing management framework in the region. Reconciling the diversity of missions and mandates for public and private organizations. Modifying or creating authority and processes necessary for governance and decisionmaking.	Agreements among public and private entities are developed to protect Highlands resources. Projects that involve local, State, Federal, and private partnerships are created to implement these strategies.
h. Use indicators to measure and monitor Highlands resource change.		
Establish and measure indicators to monitor change using existing collection methods and networks. Prepare a periodic report on the status of the Highland's resources. Provide access to monitoring data and reports. Use watershed and ecological units to help assess environmental risks and cumulative effects.	Getting agreement on indicators to be measured and commitment to monitor them. Meeting costs associated with data collection, processing, display, and distribution.	Indicators of landscape change are identified, and a monitoring system to document change is implemented. Monitoring information is distributed in a timely manner among land use planners and natural resource managers. Monitoring information is used by people and decisionmakers.

Section 4 References

New York State Department of Environmental Conservation. 2001. Draft New York State Open Space Conservation Plan. Albany; 360 p.

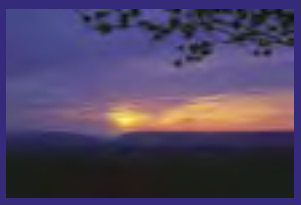
Kiviat, E.; Stevens, G. 2001. Biodiversity assessment manual for the Hudson River estuary corridor. New Paltz: New York State Department of Environmental Conservation; 508 p.

Section 5
A Fragile Future

Photograph by George M. Aronson

"Our responsibility to the Nation is to be more than careful stewards of the land. We must be constant catalysts for positive change."

Gifford Pinchot, Forester



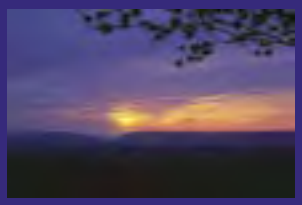
SECTION 5 A FRAGILE FUTURE

This study is the second study conducted by the USDA Forest Service since 1990 to assess land use and natural resource changes in the New York – New Jersey Highlands. Each study has reported continuing degradation of natural resources that affect the quality of life for more than 20 million people. Since 1992, some steps have been taken to conserve this nationally significant resource; however, more effort is needed to ensure the long-term sustainability of natural resources in the Highlands.

Over 11 million people depend on water flowing from and through the Highlands. Analysis of watersheds in the Highlands revealed that only 52 percent of the critical areas needed to provide this water are currently protected. Further losses or degradation of these lands can significantly affect the future quality and quantity available to residents and visitors. Similarly, additional growth pressure will increase not only the use of a limited resource, but also the amount of impervious surface, which increases surface runoff and reduces ground water recharge. Analysis identified five watersheds that may not meet future ground water demand with predicted consumption.

Continuation of existing patterns of land use change will also degrade terrestrial resources. Analysis of possible land use change in the Highlands identified 11 areas with significant resources as examples of places needing protection. These areas could be adversely affected by land use change through habitat fragmentation and deforestation. Not only would such change affect wildlife habitat conditions and biodiversity, but it would also affect water resources and recreational opportunities.

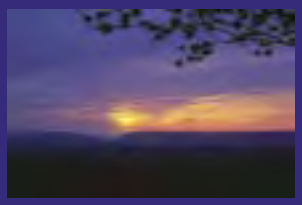
The Highlands are home to communities and people with distinctive histories. Current patterns of growth and development threaten the traditional character of the Highlands. The qualities that make this region special could be lost as it becomes built up and its distinctive communities are transformed into more homogeneous suburban areas.



The Highlands region contains a complex ecological and social system with characteristic physical, biotic, and social components. To sustain these characteristics, a holistic approach that integrates these components is needed. Because ecosystem processes cross jurisdictional and political boundaries, conservation measures must be applied not only at the local level but also at the landscape and regional levels. Funding is necessary to support the purchase of development rights or fee acquisition of critical areas; to continue monitoring natural resources and cultural attributes; and to support planning and management. These actions will be achievable only through funding from local, State, and Federal entities.

Without additional conservation efforts, the Highlands will be permanently changed, and the economic cost of supplying the ecosystem services and benefits now provided by the region would be substantial. Included would be the increased measurable costs for water treatment, public services, and infrastructure construction and maintenance. Less measurable costs would include increased stress on wildlife populations, reduced quality of life and access to recreation, and increased human health risks.

This report has identified strategies to conserve and protect the Highlands region while allowing for economic growth. Public agencies can provide some of the knowledge and funding necessary, but the implementation of these strategies will depend in large part on the involvement and commitment of residents and communities of the Highlands and communities that receive benefits from this region. Their actions will ultimately determine the future landscape in which they will live, work, and play.



Appendixes

Photograph by George M. Aronson

"Natural resources awaken in us ideals,
to be good stewards and good neighbors;
nature, in its complexity and beauty, reminds us
of our own individual potential."

Robert Stanton, Director, National Park Service

APPENDIX A

LEGISLATIVE LANGUAGE FOR THE NEW YORK – NEW JERSEY HIGHLANDS REGIONAL STUDY AND UPDATE

Fiscal Year 2002 Language in House Committee Report

The following language appears in House Report 107-103, to accompany H.R. 2217; in the Department of the Interior and Related Agencies Appropriations Bill, 2002; Title II—Related Agencies; Department of Agriculture, Forest Service, State and Private Forestry:

> The Committee notes its substantial investment in the Highlands area in New Jersey. This area encompasses over two million acres of environmentally unique and economically important lands. This area is the major source of clean drinking water to the New Jersey and New York metropolitan region as well as a critical wildlife habitat and a recreational resource for millions of people. The U.S. Forest Service is currently conducting an updated study of the Highlands region to help determine what remaining open space areas in the Highlands must be preserved. The entire region, in the backyard of the Nation's largest and most densely populated metropolitan areas, is under serious threat of development.
>
> The Committee requests the Secretary of the Interior to join the Secretary of Agriculture in reviewing the findings of this study and report to the Committee on ways the Federal government can partner with State, county, local and private efforts to preserve critical lands within this nationally significant area in the Northeast. In the past two years, $62,000,000 has been provided by these non-Federal entities to purchase critical areas within in the Highlands. The Committee believes that the Federal government should be a major partner in this preservation effort and recommends that the Secretaries consider as a model, the Sterling Forest project in the same region which has been a big success.

Fiscal Year 2001 Appropriations Language in House Conference Report (page 97) (for update of New York – New Jersey Highlands Regional Study)

Congress provided funding for the update of the New York – New Jersey Highlands Regional Study authorized by section 1244(b) of the Food, Agriculture, Conservation, and Trade Act of 1990 (104 Stat. 3547) in House Report 106-914 to accompany P.L. 106-291.

Fiscal Year 2001 Appropriations Act Language

The following language appears in H.R. 4578 of the Department of the Interior and Related Agencies Appropriations Act, 2001 (Public Print); State and Private Forestry:

> For necessary expenses of cooperating with and providing technical and financial assistance to States, territories, possessions, and others, and for forest health management, cooperative forestry, and education and land conservation activities, $226,266,000, to remain available until expended, as authorized by law, of which not less than $750,000 shall be available to complete an updated study of the New York – New Jersey Highlands under section 1244(b) of the Food, Agriculture, Conservation, and Trade Act of 1990 (104 Stat. 3547).

1990 Farm Bill Legislation (Sec. 1244 (b))

(b) NEW YORK – NEW JERSEY HIGHLANDS

(1) IN GENERAL—The Secretary is authorized to conduct a study of the region known as the New York – New Jersey Highlands, located in the States of New York, New Jersey, and Pennsylvania, including the Sterling Forest in Orange County, New York.

(2) SCOPE OF STUDY—The study authorized under this subsection (hereafter in this subsection referred to as the "study") shall include an identification and assessment of--

(A) the physiographic boundaries of the region referred to in this subsection (hereafter in this subsection referred to as the "region");

(B) forest resources of the region, including (but not limited to) timber and other forest products, fish and wildlife, lakes and rivers, and recreation;

(C) historical landownership patterns in the region and projected future landownership, management, and use, including future recreational demands and deficits and the potential economic benefits of recreation to the region;

(D) the likely impacts of changes in land and resource ownership, management, and use on traditional land use patterns in the region, including economic stability and employment, public use of private lands, natural integrity, and local culture and quality of life; and

(E) alternative conservation strategies to protect the long-term integrity and traditional uses of lands within the region.

(3) ALTERNATIVE CONSERVATION STRATEGIES—The alternative conservation strategies referred to in paragraph (2)(E) shall include a consideration of

(A) sustained flow of renewable resources in a combination that will meet the present and future needs of society;

(B) public access for recreation;

(C) protection of fish and wildlife habitat;

(D) preservation of biological diversity and critical natural areas; and

(E) new local, State, or Federal designations.

(4) PUBLIC PARTICIPATION—In conducting the study, the Secretary shall provide an opportunity for public participation.

(5) APPROPRIATIONS—There are hereby authorized to be appropriated $250,000 to carry out this subsection.

APPENDIX B

MUNICIPALITIES AND COUNTIES IN THE HIGHLANDS STUDY AREA

MUNICIPALITIES

A municipality was included in the study area even if only a portion of it fell within the study area boundary.

Municipality Name	Type	County	State
1. Alexandria	Township	Hunterdon	New Jersey
2. Allamuchy	Township	Warren	New Jersey
3. Alpha	Borough	Warren	New Jersey
4. Beacon	City	Dutchess	New York
5. Beekman	Town	Dutchess	New York
6. Belvidere	Town	Warren	New Jersey
7. Bernardsville	Borough	Somerset	New Jersey
8. Bethlehem	Township	Hunterdon	New Jersey
9. Bloomingdale	Borough	Passaic	New Jersey
10. Bloomsbury	Borough	Hunterdon	New Jersey
11. Boonton	Town	Morris	New Jersey
12. Boonton	Township	Morris	New Jersey
13. Butler	Borough	Morris	New Jersey
14. Byram	Township	Sussex	New Jersey
15. Califon	Borough	Hunterdon	New Jersey
16. Carmel	Town	Putnam	New York
17. Chester	Borough	Morris	New Jersey
18. Chester	Township	Morris	New Jersey
19. Clarkstown	Town	Rockland	New York
20. Clinton	Town	Hunterdon	New Jersey
21. Clinton	Township	Hunterdon	New Jersey
22. Cornwall	Town	Orange	New York
23. Cortlandt*	Town	Westchester	New York
24. Denville	Township	Morris	New Jersey
25. Dover	Town	Morris	New Jersey
26. East Fishkill	Town	Dutchess	New York
27. Far Hills	Borough	Somerset	New Jersey
28. Fishkill	Town	Dutchess	New York
29. Franklin	Borough	Sussex	New Jersey
30. Franklin	Township	Warren	New Jersey
31. Glen Gardner	Borough	Hunterdon	New Jersey

*The villages of Buchanan and Croton on Hudson were included as part of Cortlandt for this study and not listed separately because the U.S. Census aggregated the information for ease of analysis.

APPENDIX B MUNICIPALITIES AND COUNTIES

Municipality Name	Type	County	State
32. Greenwich	Township	Warren	New Jersey
33. Hackettstown	Town	Warren	New Jersey
34. Hamburg	Borough	Sussex	New Jersey
35. Hampton	Borough	Hunterdon	New Jersey
36. Hanover	Township	Morris	New Jersey
37. Harding	Township	Morris	New Jersey
38. Hardyston	Township	Sussex	New Jersey
39. Harmony	Township	Warren	New Jersey
40. Haverstraw	Town	Rockland	New York
41. High Bridge	Borough	Hunterdon	New Jersey
42. Highlands	Town	Orange	New York
43. Holland	Township	Hunterdon	New Jersey
44. Hopatcong	Borough	Sussex	New Jersey
45. Independence	Township	Warren	New Jersey
46. Jefferson	Township	Morris	New Jersey
47. Kent	Town	Putnam	New York
48. Kinnelon	Borough	Morris	New Jersey
49. Lebanon	Borough	Hunterdon	New Jersey
50. Lebanon	Township	Hunterdon	New Jersey
51. Liberty	Township	Warren	New Jersey
52. Lopatcong	Township	Warren	New Jersey
53. Mahwah	Township	Bergen	New Jersey
54. Mansfield	Township	Warren	New Jersey
55. Mendham	Borough	Morris	New Jersey
56. Mendham	Township	Morris	New Jersey
57. Milford	Borough	Hunterdon	New Jersey
58. Mine Hill	Township	Morris	New Jersey
59. Monroe	Town	Orange	New York
60. Montville	Township	Morris	New Jersey
61. Morris	Township	Morris	New Jersey
62. Morris Plains	Borough	Morris	New Jersey
63. Morristown	Town	Morris	New Jersey
64. Mount Arlington	Borough	Morris	New Jersey
65. Mount Olive	Township	Morris	New Jersey
66. Mountain Lakes	Borough	Morris	New Jersey
67. Netcong	Borough	Morris	New Jersey
68. Oakland	Borough	Bergen	New Jersey
69. Ogdensburg	Borough	Sussex	New Jersey
70. Oxford	Township	Warren	New Jersey
71. Parsippany-Troy Hills	Township	Morris	New Jersey
72. Patterson	Town	Putnam	New York
73. Pawling	Town	Dutchess	New York

Municipality Name	Type	County	State
74. Peapack and Gladstone	Borough	Somerset	New Jersey
75. Peekskill	City	Westchester	New York
76. Pequannock	Township	Morris	New Jersey
77. Philipstown	Town	Putnam	New York
78. Phillipsburg	Town	Warren	New Jersey
79. Pohatcong	Township	Warren	New Jersey
80. Pompton Lakes	Borough	Passaic	New Jersey
81. Putnam Valley	Town	Putnam	New York
82. Ramapo	Town	Rockland	New York
83. Randolph	Township	Morris	New Jersey
84. Ringwood	Borough	Passaic	New Jersey
85. Riverdale	Borough	Morris	New Jersey
86. Rockaway	Borough	Morris	New Jersey
87. Rockaway	Township	Morris	New Jersey
88. Roxbury	Township	Morris	New Jersey
89. Somers	Town	Westchester	New York
90. Southeast	Town	Putnam	New York
91. Sparta	Township	Sussex	New Jersey
92. Stanhope	Borough	Sussex	New Jersey
93. Stony Point	Town	Rockland	New York
94. Tewksbury	Township	Hunterdon	New Jersey
95. Tuxedo	Town	Orange	New York
96. Union	Township	Hunterdon	New Jersey
97. Vernon	Township	Sussex	New Jersey
98. Victory Gardens	Borough	Morris	New Jersey
99. Wanaque	Borough	Passaic	New Jersey
100. Warwick	Town	Orange	New York
101. Washington	Borough	Warren	New Jersey
102. Washington	Township	Morris	New Jersey
103. Washington	Township	Warren	New Jersey
104. West Milford	Township	Passaic	New Jersey
105. Wharton	Borough	Morris	New Jersey
106. White	Township	Warren	New Jersey
107. Woodbury	Town	Orange	New York
108. Yorktown	Town	Westchester	New York

APPENDIX B MUNICIPALITIES AND COUNTIES

COUNTIES

County Name	State
Bergen	New Jersey
Dutchess	New York
Hunterdon	New Jersey
Morris	New Jersey
Orange	New York
Passaic	New Jersey
Putnam	New York
Rockland	New York
Somerset	New Jersey
Sussex	New Jersey
Warren	New Jersey
Westchester	New York

APPENDIX C

ECOSYSTEM-BASED MANAGEMENT AND ECOLOGICAL CLASSIFICATION

This appendix describes a land classification system that can be used by decisionmakers, planners, and researchers for a holistic approach to natural resource planning and management in the New York – New Jersey Highlands.

ECOSYSTEM-BASED MANAGEMENT

People's actions affect ecosystems and vice versa. For example, people affect the amount of habitat for various plant and animal communities and chemical exposure. Importation of exotic pests is the result of international trade. Social and economic factors affect capital investments in environmentally friendly commerce, resource extraction, efficiency of resource utilization and the amount of resources directed to prevent or correct environmental problems.

Ecosystem-based management strives to maintain or restore the sustainability of ecosystems and to provide present and future generations a continuous flow of critical goods and services in a manner that is harmonious with ecosystem sustainability. This approach involves stepping back to provide a context for site-level planning and management. Ecosystem management harkens to the saying "an ounce of prevention is worth a pound of cure." It means saving critical ecosystem components and functional linkages, and thinking about the social, economic, and ecological interactions that affect sustainability. For example, food and forest production are affected by such things as insects, disease, drought, erosion, nutrient availability, hail and wind damage, and viable populations of pollinator insects, which in turn can be affected by factors such as disease, predation, and toxic chemicals.

ECOLOGICAL CLASSIFICATION AND MAPPING

Scientists, natural resource managers, and concerned citizens are developing a better understanding of ecological processes and functions that are necessary to sustain ecosystems. A consistent land classification system is a valuable tool for integrating information needed to holistically manage important natural resources. Currently, different groups use systems designed for specific resources, such as forest cover types, soil types, and natural vegetation types. A classification that integrates aspects of these various systems provides a common frame of reference for the many people working on issues of land-use planning and management, and ecological sustainability. The USDA Forest Service's

APPENDIX C ECOLOGICAL CLASSIFICATION

National Hierarchical Framework of Ecological Units (Cleland and others 1997) provides such a land classification system.

The national hierarchy is a regionalization, classification, and mapping system for stratifying the earth into progressively smaller areas of more similar ecological potential. The national hierarchy consists of eight levels of nested map units identified according to a progressive left to right coding scheme. These multiple levels provide the flexibility to expand or contract to greater or lesser scales of complexity for ecosystem research, monitoring, environmental analysis, and planning. The entire Eastern United States has been mapped to the subsection level (Keys and others 1995). The levels as they apply in the Highlands, from largest to smallest, are as follows:

Humid Temperate Domain (200),
Hot Continental Division (220),
Eastern Broadleaf (Oceanic) Province (221),
Lower New England Section (221A),
NY-NJ Hudson Highlands Subsection (221Ae),
Reading Prong Subsection (221Am),
Land Type Association (LTA),
Ecological Land Type (ELT), and
Ecological Land Type Phase (ELTP).

Land type associations (LTAs) and ecological land types (ELTs) were developed concurrently with the Highlands study update. The New York – New Jersey Highlands Technical Report provides details on this component of the project. The USDA Forest Service, the New York State Department of Environmental Conservation and the New Jersey Division of Parks and Forestry plan to use ecological units to provide a permanent, electronic, spatially explicit framework to organize knowledge about the Highlands' ecosystems.

LTAs are landscape-scale units of similar ecological potential and response to disturbance and human activity. LTAs reflect land formations, soil processes, major forest types, successional trends, and forest productivity. To varying degrees, they incorporate differences in stream characteristics, wetlands, and features such as disturbance patterns. They also correspond to some groupings of natural communities that tend to reoccur together.

Nine LTAs were mapped within the bedrock-controlled landscape of the glaciated Hudson Highlands Subsection (221Ae) and the unglaciated Reading Prong Subsection (221Am) (Figure C-1). LTAs were not developed for those portions of the Highlands study in adjacent subsections. Some characteristics of the LTAs are displayed in Table C-1 and Table C-2. The New York – New Jersey Highlands Technical Report includes a more detailed characterization, but further study is needed to develop more specific prescription guidelines for various management activities, such as timber production, wildlife, intensive recreation, scenic views, and ecological reserves.

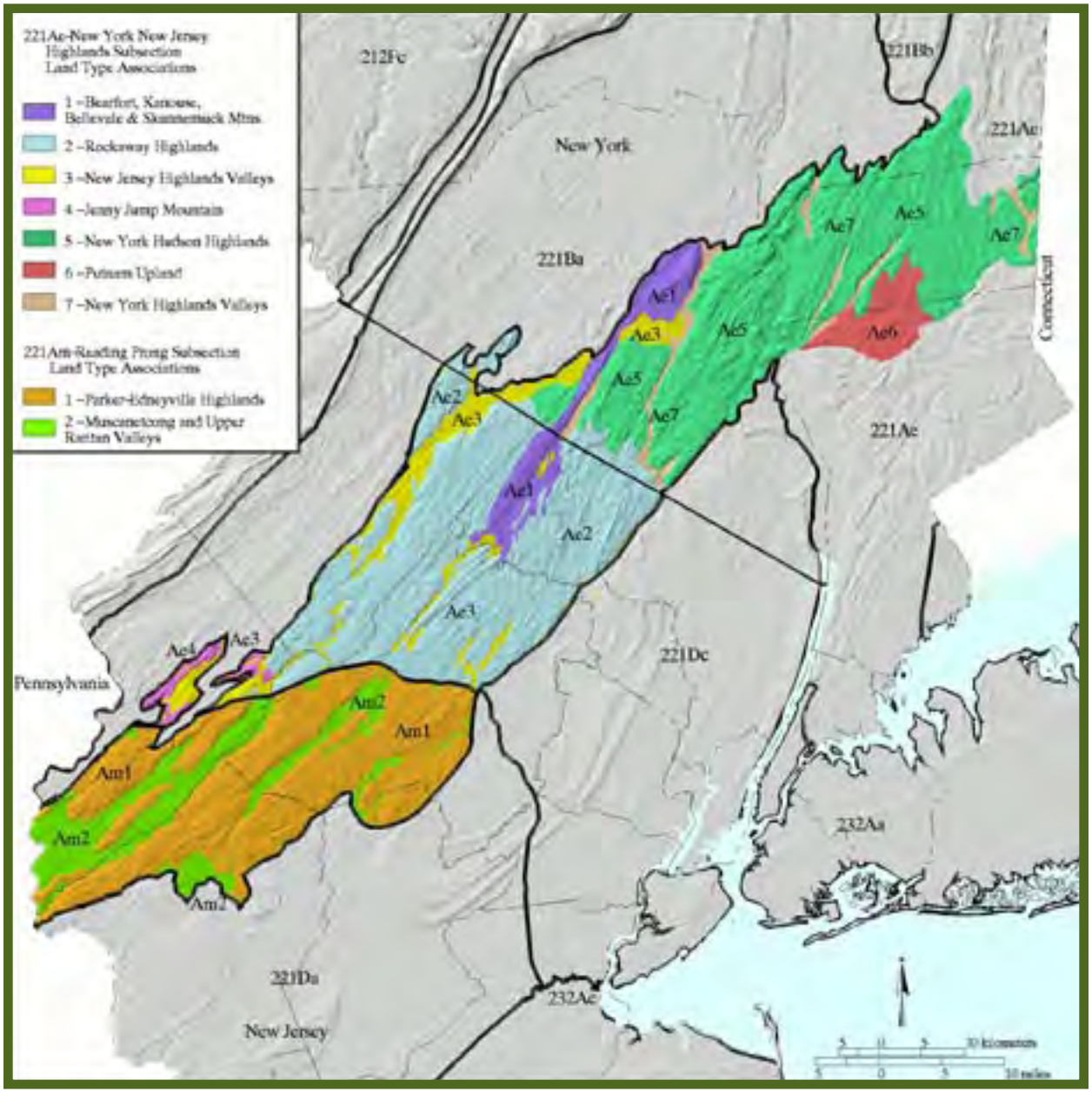


Figure C-1. Land Type Associations (LTAs) in the Highlands. LTAs were developed for the New York – New Jersey Highlands and the Reading Prong Subsections (Cleland and others 1997) during the study update, as a way to organize information about the Highlands. Subsections recognized on the map include these (Keys and others 1995):

221Ae—New York – New Jersey Highlands
221Am—Reading Prong
221Ba—Hudson Limestone Valley
221Bb—Taconic Foothills
221Bd—Kittatinny-Shawangunk Ridges
221Da—Gettysburg Piedmont Lowland
221Dc—Newark Piedmont
232Aa—Long Island Coastal Lowland and Moraine

APPENDIX C ECOLOGICAL CLASSIFICATION

Table C-1. Land Type Associations (LTAs) in the New York – New Jersey Hudson Highlands Subsection (221Ae).

LTA	Name	General description*	Common tree species**
221Ae1	Bearfort, Kanouse, Bellevale and Skunnemunk Mountains.	400-1,600 ft in elevation, 44,890 acres. Current land use: 69% upland forest, 17% developed, 2% cultivated. Patterns of shallow, well and somewhat excessively drained soils and deep well-drained soils formed in glacial till and kame terraces. Bedrock outcrops are common. Bedrock includes conglomerate, gneiss, sandstone, shale, and granite.	Red oak, chestnut oak, scarlet oak, red maple, white oak, black birch, sugar maple, American beech, eastern hemlock, sassafras, black gum, white ash, pignut hickory, tulip tree.
221Ae2	Rockaway Highlands	500-1,200 ft in elevation, 280,290 acres. Current land use: 67% upland forest, 17% developed, 1% cultivated. Patterns of very deep well and moderately well-drained soils and shallow, well and somewhat excessively drained soils in uplands formed in glacial till and loamy calcareous till and rock outcrops. Bedrock includes gneiss, granite, and ultramafic rocks.	White oak, black oak, red oak, sugar maple, American beech, black birch, red maple, white ash, sassafras, tulip tree.
221Ae3	New Jersey Highlands Valleys	190-1,246 ft in elevation, 59,300 acres. Current land use: 31% upland forest, 29% developed, 13% cultivated. Patterns of deep and very deep, well and excessively drained soils formed in glacial and glaciofluvial deposits and alluvium. Bedrock includes dolostone, gneiss, granite and marble.	Red maple, tulip tree, red oak, sugar maple, American beech, black birch, red maple, white ash, sassafras, tulip tree.
221Ae4	Jenny Jump Mountain	360-1,144 ft in elevation, 9,325 acres. Current land use: 85% upland forest, 6% developed, 3% cultivated. Patterns of very deep, and somewhat excessively drained soils formed in, residuum, colluvium and glacial till and rock outcrops. Bedrock is granite and gneiss.	Chestnut oak, red maple, American beech, white oak, sugar maple, black oak, red oak, tulip tree, white ash, black birch, shagbark hickory, bitternut hickory, pignut hickory.
221Ae5	New York Hudson Highlands	0-1,400 ft in elevation, 285,010 acres. Current land use: 75% upland forest, 13% developed, 1% cultivated. Patterns of very deep, well-drained loamy soils to shallow soils formed in glacial till plains, kame deposits and bedrock outcrops. Bedrock includes gneiss, and amphibolite.	Red oak, chestnut oak, red maple, black birch, white oak, sugar maple, eastern hemlock, white ash, pignut hickory, black oak, tulip tree.
221Ae6	Putnam Deep Till Uplands	200-600 ft in elevation, 28,350 acres. Current land use: 33% upland forest, 49% developed, 3% cultivated. Patterns of very deep, well-drained loamy soils formed in glacial till, outwash sand and gravel and rock outcrops. Bedrock is predominately gneiss.	Red oak, sugar maple, red maple, white oak, white ash, black birch, American elm, black oak, tulip tree, chestnut oak, pignut hickory.
221Ae7	New York Highlands Outwash Valleys	300-700 ft in elevation and 50-300 ft in elevation by Hudson River, 22,155 acres. Current land use: 45% upland forest, 31% developed, 5% cultivated. Very deep, somewhat excessively and excessively drained soils formed in outwash sand and gravel, till, kame deposits, alluvium, and colluvium. Bedrock includes gneiss, dolostone, amphibolite.	Red maple, white ash, red oak, sugar maple, silver maple, tulip tree, black oak, green ash, American beech, cottonwood, sycamore.

*Most common components are listed first. Bedrock types are listed if they are more than 10 percent of the composition.
**Tree species were subjectively selected.

Table C-2. Land Type Associations (LTAs) in the Reading Prong Subsection (221Am).

LTA	Name	General description*	Common tree species**
221Am1	Parker-Edneyville Highlands	120-1,300 ft in elevation, 217,695 acres. Current land use: 54% upland forest, 24% developed, 13% cultivated. Very deep, somewhat excessively drained soils formed in residuum and colluvium. Bedrock includes granite, gneiss and ultramafic rocks.	White oak, black oak, northern red oak, sugar maple, American beech, black birch, red maple, white ash, tulip tree.
221Am2	Musconetcong and Upper Raritan Valleys	120-1,100 ft in elevation, 80,570 acres. Current land use: 16% upland forest, 29% developed, 38% cultivated. Patterns of deep, well-drained soils formed in old glacial drift, residuum and colluvium. Bedrock includes dolostone and shale.	Tulip tree, white ash, red maple, sugar maple, black birch, American beech, white oak, yellow birch, American elm, shagbark hickory.

*Most common components are listed first. Bedrock types are listed if they are more than 10 percent of the composition.
**Tree species were subjectively selected.

LTAs could be used as a framework for cooperation in the implementation of conservation measures to address concerns identified in the Highlands study update. LTAs can be used as an analysis framework to identify the impacts of varying distributions of land uses. An increasing number of State and private management and research organizations are using the National Hierarchy as a framework for study and as a tool to assist in adapting regional management guidelines to local and regional management conditions. Examples of uses of the smaller, more detailed Ecological Land Types and Ecological Land Type Phases include the application of silvicultural systems, and calibrating and applying timber growth and wildlife habitat models.

APPENDIX C REFERENCES

Cleland, David T.; Avers, Peter E.; McNab, W. Henry; Jensen, Mark E.; Bailey, Robert G.; King, Thomas; Russell, Walter E. 1997. National hierarchical framework of ecological units. In: Boyce, Mark S.; Haney, Alan, eds. Ecosystem management: applications for sustainable forest and wildlife resources. New Haven, CT: Yale University Press; 200 p.

Keys, James E., Jr.; Carpenter, Constance A.; Hooks, Susan L.; Koenig, Frank G.; McNab, W.; Henry, Russell; Walter, E.; Smith, Marie-Louise. 1995. Ecological units of the eastern United States—first approximation (map and booklet of map unit tables). Atlanta, GA: U.S. Department of Agriculture, Forest Service. (Available on CD-ROM consisting of GIS coverage in ARCINFO format and map unit descriptions of subsection and sections.)

APPENDIX D

WORK PLAN AND BUDGET FOR THE STUDY UPDATE

A work plan was developed to complete the study update. This plan included a listing of the major steps in the process, a timeline, and budget for the use of Federal funds.

SUMMARY OF WORK PLAN

Major steps	Completion date
Complete study logistics	January 2001
Identify issues and study questions	March 2001
Initiate conservation projects*	June 2001
Data collection/assessment	September 2001
Analysis of data	November 2001
Identify conservation areas	January 2002
Draft study report	April 2002
Public comment period	April – May 2002
Final study report	December 2002

*The Land Conservation Project Program was initiated by the U.S. Department of Agriculture, Forest Service, to provide matching funds for pilot initiatives in New Jersey and New York Highlands communities that demonstrated the use of comprehensive resource information and involved collaborative land-use decisionmaking. See Appendix K for more information.

BUDGET

Expense	Amount
Salary	$175,000
Operations	30,000
Assessment and analysis	425,000
Land conservation projects	100,000
Study report	20,000
Total	**$750,000**

Appendix E

Study Team Members

The study team guided the process and provided the technical services and skills needed to conduct the study and prepare the report. Team members are listed in alphabetical order under their organization.

U.S. Department of Agriculture, Forest Service:

Mark Buccowich, landowner assistance program specialist
Connie Carpenter, sustainability coordinator
Martina Hoppe, regional planner
Marcus Phelps, study coordinator and forester
Wayne Zipperer, research forester

New York State Department of Environmental Conservation:

Stephanie Diamond, research assistant

Rutgers University, Grant F. Walton Center for Remote Sensing and Spatial Analysis:

Colleen Hatfield, assistant professor
Richard Lathrop, director
David Tulloch, assistant professor

U.S. Department of the Interior, Geological Survey:

Vince dePaul, hydrologist
Don Rice, hydrologist
Otto Zapecza, chief hydrologist

Regional Plan Association:

Robert Pirani, director of environmental programs

New Jersey Department of Environmental Protection:

Wayne Martin, regional forester

APPENDIX F

WORK GROUP MEMBERS

The work group members ensured a regional perspective, guided the study process, and commented on draft material as potential consumers of the study report and results.

Mr. Roger Akeley, Planning Commissioner, Dutchess County (New York)
Ms. Carol Ash, Executive Director, Palisades Interstate Park Commission
Mr. James Barresi, State Forester, New Jersey Department of Environmental Protection
Ms. Susan Bates, Executive Director, Hudson Highlands Land Trust
Mr. Thomas Baxter, Executive Director, New Jersey Water Supply Authority
Mr. Jim Beil, Assistant Director of Lands and Forests, New York State Department of Environmental Conservation
Mr. Robert Bondi, County Executive, Putnam County (New York)
Mr. Andrew Borisuk, private citizen
Mr. William Borra, Chairman of Board of Directors, Builders Association of Northern New Jersey
Mr. William Bzik, Director of Planning, Somerset County (New Jersey)
Mr. Bradley Campbell, Commissioner, New Jersey Department of Environmental Protection
Mr. John Capozucca, Chairman, Bloomingdale Environmental Commission (New Jersey)
Ms. Bernadette Castro, Commissioner, New York State Office of Parks, Recreation, and Historic Preservation
Mr. Michael Catania, State Director, Nature Conservancy of New Jersey
Ms. Tracy Cates, private citizen
The Honorable Hillary Rodham Clinton, United States Senate (New York)
The Honorable Jon Corzine, United States Senate (New Jersey)
Ms. Erin Crotty, Commissioner, New York State Department of Environmental Conservation
Mr. Clifford Day, New Jersey Field Office Supervisor, United States Fish and Wildlife Service
Mr. David Dech, Director of Planning, Warren County (New Jersey)
Mr. Mario DelVicario, Chief of Community and Ecosystem Protection Branch, Environmental Protection Agency (New York)
Mr. John Di Maio, Director, Board of Freeholders, Warren County (New Jersey)
Mr. Tim Dillingham, private citizen
Ms. Kathleen Donovan, County Clerk, Bergen County (New Jersey)
Ms. Donna Drewes, Director, North Jersey Resource Conservation and Development

Ms. Sally Dudley, Executive Director, Association of New Jersey Environmental Commissions
Mr. Frank Dunstan, Director, Division of Lands and Forests, New York State Department of Environmental Conservation
Mr. Peter Eagler, Director, Board of Freeholders, Passaic County (New Jersey)
Mr. Paul Elconin, Mid-Hudson Land Steward, Open Space Institute
Ms. Ada Erik, member, Skylands Citizens for the Land, Environment, and Neighborhoods (CLEAN)
Mr. Christopher Falcon, Vice Chair, Morris 2000
Mr. Ronald Farr, Environmental Scientist, North Jersey District Water Supply Commission
Ms. Ella Filippone, Executive Administrator, Passaic River Coalition
Mr. Michael Flynn, Director of Intergovernmental Affairs, Senator Robert Torricelli's Office (New Jersey)
The Honorable Rodney P. Frelinghuysen, United States House of Representatives (New Jersey)
Mr. James Gaffney, Director, Watershed Division, Northeast Bureau, New Jersey Department of Environmental Protection
Mr. Peter Garrison, Planning Commissioner, Orange County (New York)
Mr. John Gebhards, Executive Director, Sterling Forest Partnership
Ms. Sybill Gilbert, private citizen
Mr. Thomas Gilbert, Executive Director, Highlands Coalition
The Honorable Benjamin Gilman, United States House of Representatives (New York)
Mr. Tom Gilmore, President, New Jersey Audubon Society
Mr. Thomas Gissen, Executive Vice President, Ginsburg Development Corporation
Mr. Edward Goodell, Executive Director, New York-New Jersey Trail Conference
Ms. Erma Gormley, County Clerk, Sussex County (New Jersey)
Ms. Joanne Harkins, Director of Land Use and Planning, New Jersey Builders Association
The Honorable Maria Harley, Mayor, West Milford Township (New Jersey)
Ms. Rose Harvey, Vice President, Trust For Public Land
Ms. Helen Heinrich, Research Associate, New Jersey Farm Bureau
Ms. Carmen Heitczman, President, Orange County Federation of Sportsmen's Clubs
Ms. Elizabeth Herland, Refuge Manager, Wallkill River National Wildlife Refuge
The Honorable Maurice Hinchey, United States House of Representatives (New York)
The Honorable Rush Holt, United States House of Representatives (New Jersey)
Mr. Howard Horowitz, Associate Professor, Ramapo College
Mr. Anthony Houston, Town Supervisor, Town of Warwick (New York)
Mr. George Howard, Executive Director, New Jersey State Federation of Sportsmen Clubs

APPENDIX F WORK GROUP MEMBERS

Ms. Valerie Jewett, District Representative, Congressman Rodney Frelinghuysen's Office (New Jersey)
Mr. Richard Jones, Planner, Department of Planning, Orange County (New York)
Ms. Kim Kaiser, Highlands/GIS Project Director, Association of New Jersey Environmental Commissions
Mr. Richard Kane, Consultant to the President, New Jersey Audubon Society
Colonel Michael D. Kelley, Department of Geography and Environmental Engineering, United States Military Academy
Mr. John Kellogg, Director of Planning, Hunterdon County (New Jersey)
The Honorable Sue Kelly, United States House of Representatives (New York)
Ms. Jane Kenny, Administrator, Region II, Environmental Protection Agency
Mr. Ted Kerpez, Wildlife Manager, New York State Department of Environmental Conservation
Mr. Walter P. Krich, Jr., Director of Planning and Development, Morris County (New Jersey)
The Honorable John Krickus, Mayor, Washington Township (New Jersey)
Ms. Joyce M. Lannert, Commissioner, Department of Planning, Westchester County (New York)
Ms. Barbara Lawrence, Executive Director, New Jersey Future
Ms. Mada Liebman, Senior Adviser, Senator Jon Corzine's Office (New Jersey)
Mr. John J. Lynch, Director, Planning and Development, Putnam County (New York)
Mr. Joseph Martens, President, Open Space Institute
Mr. William Mazzuca, Town Supervisor, Philipstown (New York)
Mr. Seth McKee, Executive Director, Scenic Hudson
Ms. Kathy Moser, Executive Director, The Nature Conservancy
Mr. George D. Muller, Director, Board of Freeholders, Hunterdon County (New Jersey)
Ms. Barbara Murray, Senior Planner, Somerset County Planning Board (New Jersey)
Ms. Diane Nelson, Trustee, Upper Rockaway River Watershed Association
Ms. Margaret Nordstrom, Member, New Jersey State Planning Commission
Mr. Jerry Notte, Principal, MWH – Montgomery, Watson, Harza
The Honorable Craig A .Ollenschleger, Mayor, Bloomingdale Borough (New Jersey)
Mr. Richard Osborn, Team Leader, Northwest Bureau, Green Acres
Ms. Diane M. Paganelli, Executive Director, Morris 2000
Mr. Jason Patrick, Scientist, Project Coordinator, Environmental Defense
Ms. Michelle Powers, Principal Planner, Putnam County Planning Department (New York)
Ms. Norma Ramos, Regional Representative, Sierra Club
Mr. Joseph G. Rampe, County Executive, Orange County (New York)
Mr. John L. Rigolizzo, Jr., President, New Jersey Farm Bureau
Mr. James Rogers, Director of Planning, Passaic County (New Jersey)

The Honorable Marge Roukema, United States House of Representatives (New Jersey)
Mr. J. Eric Scherer, River Navigator, American Heritage Rivers Initiative – Hudson River
The Honorable Charles E. Schumer, United States Senate (New York)
Dr. William Schuster, Executive Director, The Black Rock Forest Consortium
Mr. Matthew Schwab, New York City Department of Environmental Protection
Mr. Herbert Simmons, Department of Community Affairs, New Jersey Office of State Planning
Mr. Joseph Simoes, Planner, Rockland County Planning Department (New York)
Ms. Kathy Baker Skafidas, Executive Director, Skylands CLEAN
Mr. Zinneford Smith, Executive Director, Newark Watershed Corporation
Mr. Andrew J. Spano, County Executive, Westchester County (New York)
The Honorable Benjamin L. Spinelli, Mayor, Chester Township (New Jersey)
Ms. Barbara Spinweber, Environmental Scientist, United States Environmental Protection Agency, Region II
Mr. Matt Sprung, Land Surveyor, Millennium Homes
Mr. William Steinhaus, County Executive, Dutchess County (New York)
Mr. Ira Stern, Director of Watershed Planning and Community Affairs, New York City Department of Environmental Protection
Ms. Lisa Stern, Team Leader, Northeast Bureau, Green Acres
Mr. Eric Stiles, Vice President for Conservation and Stewardship, New Jersey Audubon Society
Mr. Fred Suljic, Director of Planning, Sussex County (New Jersey)
Mr. James Tanner, Town Supervisor, Pawling (New York)
Mr. Jeffrey Tittel, Director, New Jersey Sierra Club
The Honorable Robert Torricelli, United States Senate (New Jersey)
Mr. James Tripp, General Counsel, Environmental Defense
Mr. Daniel Van Abs, Manager, Watershed Protection, New Jersey Water Supply Authority
Mr. Michael Van Clef, Director of Science and Stewardship, Nature Conservancy of New Jersey
Mr. C. Scott Vanderhoef, County Executive, Rockland County (New York)
Mr. Theodore Vandervleit, Director, Planning and Economic Development, Bergen County (New Jersey)
Ms. Lisa Voyce, Water Supply Project Director, Association of New Jersey Environmental Commissions
Ms. Barbara Walsh, Manager, Local Planning Assistance, New Jersey Office of State Planning
Mr. Brian Walsh, Press Secretary and Legislative Assistant, Congressman Benjamin Gilman's Office (New York)
Dr. James J. Yarmus, Commissioner of Planning, Rockland County (New York)
Mr. Robert Zaborowski, Director of Board of Freeholders, Somerset County (New Jersey)
The Honorable Robert L. Zelley, Mayor, Greenwich Township (New Jersey)

Appendix G

Public Comments on the Draft Report

Persons and organizations that submitted detailed comments

Names are listed in the order in which comments were received during the public comment period. The date corresponds to the date on the letter.

1. Senator Robert Torricelli, United States Senate, 4/22/02
2. Joseph Maraziti, New Jersey State Planning Commission, 4/18/02
3. Jane Geisler, Mid-Hudson Adirondack Mountain Club, 4/19/02
4. James Darrar, 4/19/02
5. Patti Lynch, 4/22/02
6. Robert Cherdack, 4/22/02
7. JoAnn Bowman, 4/23/02
8. Judy Strachan, 4/23/02
9. Tina Schvejda, New Jersey Sierra Club, 4/18/02
10. Janet Burnet, Town of Ramapo (NY) Parks and Recreation Foundation, 4/23/02
11. Seth McKee, Scenic Hudson, 4/23/02
12. Geoff Welch and Dorice Madronero, Rockland County (NY) Conservation Association, 4/23/02
13. Dave Colavito, 4/23/02
14. Debra Corr, Mid-Hudson Horse Trails Association, 4/23/02
15. Debra Corr, Town of Goshen (NY), 4/23/02
16. Thomas Gilbert, Highlands Coalition, 4/23/02
17. Diane Nelson, Upper Rockaway River Watershed Association, 4/22/02
18. Lorraine Caruso, League to Save Open Space, 4/22/02
19. James Daley, Eastern Forest Partnership, 4/22/02
20. Russell Felter, Pyramid Mountain Committee, 4/22/02
21. Jason Patrick, Environmental Defense, 4/22/02
22. Thomas Dallesio, Regional Plan Association, 4/22/02
23. Barbara Murray, Somerset County (NJ), 4/24/02
24. Joanne Harkins, New Jersey Builders Association, 4/25/02
25. Ross Kushner, Pequannock River Coalition, 4/24/02
26. John Arbo, 4/25/02
27. Anthony Rego, 4/23/02
28. J. Thomas White, 4/24/02
29. Fred Akers, 4/24/02
30. Mary Kuhner, 4/26/02
31. N. McLaughlin, 4/25/02
32. Dan Van Abs, New Jersey Water Supply Authority, 4/25/02

33. Thomas Baptist, Audubon Connecticut, 4/26/02
34. Barbara Snyder, 4/29/02
35. Nancy Critchley, 4/26/02
36. Robert A. Kelly, 5/1/02
37. Lisa Voyce, ANJEC, 5/2/02
38. Lawrence Wolfson, 4/29/02
39. Carl Pauli, 4/28/02
40. Philip Smith, Schoor DePalma, 4/23/02
41. Jane Tousman, 4/26/02
42. Barbara Walsh, New Jersey Office of State Planning, 5/2/02
43. Eric Antebi, Appalachian Mountain Club, 4/23/02
44. Matt Sprung, New Jersey Builders Association, 5/2/02
45. Sibyll Gilbert, Oblong Land Conservancy, 4/30/02
46. Lucy Meyer, Pyramid Mountain Committee, 5/2/02
47. Faith Teeple, 4/30/02
48. Lorraine Stephens, 4/26/02
49. Erna Masone, 5/2/02
50. Lucy Thomson, 4/28/02
51. Mary McGiller, 4/28/02
52. Clare Wharton, 4/29/02
53. M.N., 4/29/02
54. Robert Bzik, Somerset County (NJ) Planning Board, 5/2/02
55. Jim DeStephano, 5/1/02
56. George Krevet, 4/29/02
57. Patricia Rogers, 4/30/02
58. Josephine Heimers, 5/2/02
59. Gayle Hendrix, 5/2/02
60. Edward Heimers, 4/30/02
61. Robbie Oxnand, 4/29/02
62. Mimi Starrett, 4/29/02
63. Bradley Campbell, New Jersey Department of Environmental Protection, 5/3/02
64. John Rigolizzo, New Jersey Farm Bureau, 5/2/02
65. Fred Suljic, Sussex County (NJ) Department of Engineering and Planning, 5/3/02
66. David Dech, Warren County (NJ) Planning Department, 5/1/02
67. Kathy Baker Skafidas, Skylands Citizens for the Land, Environment and Neighborhoods (CLEAN), 5/2/02
68. Richard Whiteford, 5/1/02
69. Paul Elconin, Open Space Institute, 5/3/02
70. Cathy McCartney, Mountain Preservation Society, 4/27/02
71. Carol Spencer, 5/3/02
72. Maureen Ogden, 5/2/02
73. Pieter Prall, 5/2/02

APPENDIX G PUBLIC COMMENTS ON THE DRAFT REPORT

74. Charles Kopp, 5/2/02
75. Darlene Warga, 4/30/02
76. Dalous LaRusso, 5/1/02
77. Michele S. Byers, New Jersey Conservation Foundation, 5/3/02
78. Ella Filippone, Passaic River Coalition, 5/3/02
79. Robert Herberger, New York State Department of Environmental Conservation, 5/1/02
80. Neil Woodworth, Adirondack Mountain Club, 5/3/02
81. Laurie Wallace, Friends of the Great Swamp, 5/2/02
82. Martin Treat, Friends of the Sparta Mountain, 5/3/02
83. Craig Ollenschleger, Borough of Bloomingdale (NJ), 5/7/02
84. Judy Hoyer, 5/3/02
85. Warren Marshall, 4/30/02
86. Eric Stiles, New Jersey Audubon Society, 5/3/02
87. Justin Bloom, Riverkeeper, 5/3/02
88. George Horzepa, New Jersey Department of Agriculture, 5/3/02
89. Tom Gilbert, Highlands Coalition, 5/3/02
90. Raymond Zabihach, Morris County (NJ) Planning Board, 5/6/02
91. Joe Simoes, Rockland County (NY) Planning Board, 5/3/02
92. Clifford Day, US Fish and Wildlife Service, 5/8/02
93. Sandra Cohen, NJ Department of Environmental Protection, Division of Watershed Management, 5/8/02
94. Public Listening Session transcript from April 22 and 23, 2002, 5/10/02

SUMMARY OF PUBLIC COMMENTS

Comments that emerged were categorized into the following sections: land resources, water resources, future change scenarios, conservation values assessment, conservation "gap" analysis (resources at risk), conservation strategies, and general comments.

Land Resources

- Focus more on farm assessment portion of study.
- Focus more on importance of wildlife and biodiversity.
- Emphasize importance of forest protection.
- Explain extent and impacts of acid rain and nitrogen deposition on forest health.
- Explain cumulative impact of pests, deer, and pollution on forest health.
- Provide workable solutions for management of invasive and exotic species.
- Show specific core areas of forest habitat loss.
- Show extent of large contiguous tracts of unprotected forest habitat.

Water Resources

- Estimate water demand and supply for persons outside the Highlands relying on Highlands water.
- Estimate number of people who depend on Highlands aquifers and reservoirs to include water that flows through the Croton watershed, and an estimate of the Highlands' contribution to the Raritan and Delaware systems.
- Manage drought and flood conditions in the region.
- Measure status of water resources.
- Include information on the importance of enhancing recharge, not just minimizing impervious surface.
- Revise regional water budget to give credit for discharges back into Highlands streams if this water is from outside the Highlands study area.
- Emphasize negative impact of impervious surfaces.
- Consider economics of providing water services and replacing natural water resources.

Future Change Scenarios

- Identify locations within the region that should be designated to provide housing and jobs.

Conservation "Gap" Analysis (retitled Resources at Risk in the final report)

- Provide greater detail on Conservation Values Assessment (CVA).
- Protect areas designated as high priority for water, forestry, biodiversity, agriculture, and recreation.
- Approximate costs of acquiring major gap areas ("gap" areas retitled "conservation focal areas" in the final report).
- Examine priority areas to avoid overlap with existing State and Federal transportation and infrastructure investments.
- Include New York's Great Swamp as a major gap area ("gap" areas retitled "conservation focal areas" in the final report).
- Include acreage amounts in addition to percentages for gap figures ("gap" areas retitled "conservation focal areas" in the final report).

Conservation Strategies

- Strengthen the Forest Service's role in planning, land acquisition, and stewardship.
- Designate remaining acres in the Highlands as a National Forest.
- Establish predictable funding sources from Federal, State, county, and local government levels for land acquisition.
- Help local communities and farm landowners balance growth and economic viability with environmental protection.

- Develop strong recommendations and tie them to the assessment findings.
- Create new planning paradigms such as regional compacts and regional planning organizations.
- Coordinate land use planning in Highlands through cooperation of regional, State, county and local entities.
- Promote smart growth principles on the local level with Federal assistance for economic development, affordable housing and open space preservation.
- Emphasize the national significance of the Highlands.
- Measure how open space and land use elements in municipal and county master plans are consistent with Highlands study.
- Develop a Highlands report card with input from stakeholders to ensure success.
- Set specific targets with benchmarks for measuring success in the Highlands.
- Emphasize water protection strategies.
- Emphasize the impact of the drought on water resources.

General Comments

- Provide more technical data and critical review of representations and recommendations.
- Describe data sources, analysis and methodology more fully.
- Explain what the report does not assess.

APPENDIX H

TOPICS IN THE NEW YORK – NEW JERSEY HIGHLANDS TECHNICAL REPORT

The New York – New Jersey Highlands Technical Report supplements the New York – New Jersey Highlands Regional Study: 2002 Update. The technical report provides greater detail on the data sources, methodology, and results of the resource assessment and on analyses conducted as part of the study process. The technical report enables readers to access and view the scientific information and files used to prepare this study update. Information about how to obtain a copy of the technical report is on the Highlands Web site at www.fs.fed.us/na/highlands. Interested persons may also contact the USDA Forest Service at 610-557-4124.

The Technical Report includes the following topics:

Resource Assessment

Water

Ground Water

Aquifer information including ground water use data, domestic water use, trends in ground water levels, and data availability from Web sites.

Surface Water

Streamflow information from gauging stations, surface water use data, and data availability from Web sites.

Water Budget

Watershed analysis by Hydrologic Unit Codes 11 and 14, explanation of the watershed model, and watershed budget calculations and related effects of land use change scenarios.

Water Quality

Background water quality information, water quality trends, and data availability from Web sites.

Forest and Timber

Status of forests and timber resources including USDA Forest Service Forest Inventory and Analysis data on forest types, timber volumes, and growth and removals.

Forest Health

Information on forest pests, stresses on forest condition, and current trends in forest health.

APPENDIX H TOPICS IN THE TECHNICAL REPORT

Forest Land Ownership

Forest landowner survey data, trends in forest land ownership, and the availability of National Woodland Owner Survey information on the internet.

Biodiversity

Status of biodiversity including animal and plant species, spatial distribution of habitats, and community diversity analysis.

Recreation and Open Space

Documentation of recreational resources of regional importance, database of publicly and privately owned open space, recreational use data, and viewshed analysis.

Farmland

Status and trends of agriculture and farmland, spatial distribution of farmland and prime farm soil, and acreage estimates.

Ecosystem-Based Management and Ecological Classification

Explanation and application of the ecological classification system, results of the ecological unit mapping process in the Highlands, and ecological unit descriptions.

Conservation Values Assessment

Explanation of the methodology used for the Conservation Values Assessment, discussion of resource values, and tabular and map display of analysis results.

Potential Changes and Resources at Risk

Population

Population and selected demographic information on the Highlands using 1990 and 2000 data, summary statistics, tabular results, and maps for display.

Build-out Analysis

Explanation of methodology used to analyze land use and population change for future land use scenarios, description of high and low constraint scenarios, and associated maps.

Likelihood of Land-Use Change: Econometric Modeling

Explanation of the methodology used to identify areas of likely future change based on an econometric model, description of the variables used for the analysis, and tabular and map displays of the likelihood of change.

Changes in Land Use and Land Cover

Description of method used for land cover mapping, comparison of 1972, 1984, 1995 and 2000 land cover, and tabular and map display of analysis results.

Landscape Indicators of Forest and Watershed Integrity

Description of indicators, analysis of build-out scenarios by Hydrologic Unit Code for selected time periods, and maps of predicted change.

Resources at Risk

Explanation of methodology for comparing existing protected resources with assessed need, tabular results, and maps showing the spatial distribution of the conservation focal areas.

APPENDIX I

RESOURCE ASSISTANCE PROGRAMS

This appendix describes a wide variety of assistance programs offered by Federal and State agencies. Programs are divided into these categories: forest, farmland, wetland, wildlife, multiple resources, and fire.

FOREST RESOURCE ASSISTANCE PROGRAMS

Cooperative Forest Management Program for New York State

The Cooperative Forest Management Program is administered by the New York State Department of Environmental Conservation to encourage private forest landowners in New York to apply sound forest management and practices to their woodlands. A professional forester evaluates the existing forest management opportunities and develops written management recommendations for private woodlands. All recommendations are based on sound forest practices. Assistance is provided for a diversity of uses that include—but are not limited to—harvest, marketing, establishing forest plantations, care for immature stands, and timber marking. Services are free to the 500,000 private landowners of 14.5 million acres of forest in New York State.

Economic Action Program

The Economic Action Program is administered by the USDA Forest Service and consists of three separate programs: Rural Community Assistance programs; Forest Products Conservation and Recycling programs; and Market Development and Expansion programs. It helps to diversify and improve local economies through the wise and more complete use of renewable forest resources, and helps to create jobs. The program strengthens the capacity of communities to develop sustainable local economies. It also stimulates job creation in ways that promote environmentally sound use of forest-based natural resources. The Economic Action Program provides technical expertise and financial assistance for sustainable economic development, including marketing, exporting, recycling, and industrial processing of wood and other forest products and services.

Forest Land Enhancement Program

This new incentive program administered by the USDA Forest Service was established in the 2002 Farm Bill. Forest owners will be provided a cost-share up to 75 percent for such practices as tree planting, wildlife habitat enhancement, water quality protection, endangered species protection, invasive weed control, forest health practices, timber stand improvement, and agroforestry.

A management plan must be in place for an owner to be eligible, and cost-share is limited by 1,000 acres of practices or up to 5,000 acres with a special waiver. Minimum acreage limits will be set on a State-by-State basis. This program also provides technical and educational support.

Forest Legacy Program

The Forest Legacy Program is a USDA Forest Service program that supports State efforts to protect environmentally sensitive forest lands threatened by conversion to nonforest uses. Forest Legacy is a voluntary program designed to encourage the protection of privately owned forest lands. The Forest Legacy Program helps the States develop and carry out their forest conservation plans. It encourages and supports acquisition of conservation easements, legally binding agreements transferring a negotiated set of property rights from one party to another, without removing the property from private ownership. Most Forest Legacy conservation easements restrict development, require sustainable forestry practices, and protect other values.

Forest Stewardship Program

The Forest Stewardship Program is administered by the USDA Forest Service and delivered on the ground through State forestry agencies. This program brings professional natural resource management expertise to nonindustrial private forest landowners to help them in developing forest stewardship plans. By providing financial support to planning efforts, the Forest Stewardship Program brings the expertise of State foresters, the Extension Service, Soil and Water Conservation Districts, Resource Conservation and Development Councils, biologists, and private consultants to private landowners, local governments, and environmental organizations. Generally, Forest Stewardship Program participants own less than 1,000 acres of land; however, there is no maximum ownership restriction. Participation is available to individuals and noncommercial landowners who agree to follow their plan recommendations for at least 10 years. The Forest Stewardship Program is not a cost-share program, but rather it provides technical and planning guidance, encouraging multiple-resource management.

Forest Tax Law Program for New York State

New York State, in cooperation with the New York State Department of Environmental Conservation, has enacted a number of laws granting tax relief for qualifying landowners to encourage the long-term ownership of woodlands for the production of forest crops and to increase the likelihood of a more stable forest economy. As early as 1912, there were provisions for tax concessions on forest lands, culminating in the present Section 480-A of Real Property Tax Law passed in 1974. Tracts of 50 contiguous acres, exclusive of portions not committed to the production of forest crops, are eligible. To be eligible, timber harvesting conducted within 3 years before application must have been done in

accordance with a sound forest management program. Property owners must commit their land to the production of forest crops and follow a management plan prepared by a forester and approved by the New York State Department of Environmental Conservation, for the next succeeding 10 years beginning each year that a tax exemption is received. Tax savings vary considerably. If analysis shows that a tax reduction can be obtained, it is recommended that a forester be consulted to determine the approximate costs of preparing a management plan and making investments as required by the plan.

Urban and Community Forestry Program

The Urban and Community Forestry Program is administered by the USDA Forest Service and promotes conservation and management of forests and related natural resources. The program provides technical expertise and financial assistance for the planning and management of related natural resources in urban and community forests. It provides Federal funding through the State forester for community grants for the stewardship of urban and community forests including resource inventory, tree planting, proper tree care, and environmental restoration.

Watershed Forestry Program

This program is administered by the nonprofit organization called the Watershed Agricultural Council. The Watershed Forestry Program promotes good forestry by training loggers and foresters about best management practices that prevent nonpoint source pollution. The program also encourages private landowners to become good stewards of forest resources and educates the public about how forests can help protect the water supply. Funding for this partnership program comes from New York City Department of Environmental Protection and the USDA Forest Service.

FARMLAND RESOURCE ASSISTANCE PROGRAMS

Conservation Reserve Program

The Conservation Reserve Program (CRP) is a voluntary program for agricultural landowners delivered through the USDA Farm Service Agency and the USDA Natural Resources Conservation Service. The CRP provides technical and cost-share assistance for the conversion of highly erodible cropland and other environmentally sensitive cropland areas to permanent vegetative cover. "Traditional" CRP enrollments target acreages and enroll cropland through regularly scheduled, periodic national sign-ups. Through CRP, annual rental payments and cost-share assistance is offered to establish long-term, resource-conserving covers on eligible farmland. "Continuous" CRP enrollments target smaller tracts and are held at all times through the year. Continuous signup provides management flexibility to farmers and ranchers to implement certain high-priority conservation practices on eligible land and may increase eligibility

for certain enhancements. Both programs have basic requirements in common: cropland must have been planted or considered planted to an agricultural commodity in 2 of the last 5 crop years, and marginal cropland must be devoted to a riparian buffer or planted to trees. Landowners must enter into a 10- to 15-year contract upon enrollment into CRP. Through the program, a landowner can be reimbursed up to 50 percent of the cost of establishing a permanent cover on approved cropland. Tree planting is the preferred practice for permanent forest cover and water quality protection. Once permanent cover is established, the landowner receives annual rental payments for 10 to 15 years depending on the cover type. Payments are based on the average value of dry land cash rent or the cash rent equivalent for the past 3 years. Additional financial incentives are available for select land use or maintenance practices.

Environmental Quality Incentives Program

The Environmental Quality Incentives Program (EQIP) is administered by the USDA Natural Resources Conservation Service and the USDA Farm Service Agency. EQIP provides technical and cost-share assistance to farmers and ranchers in priority areas to address serious threats to topsoil, water, and related natural resources. Priority areas can include watersheds, environmentally sensitive areas, or areas with significant soil and water-related natural resource concerns. Eligible landowners include only those involved in livestock or agricultural production. Livestock operations with more than 1,000 head are ineligible. Lands that are eligible include cropland, pastureland, rangeland, and forest land. A site-specific conservation plan must be developed. EQIP contracts are offered to participating landowners in 5- to 10-year durations to provide cost-share payment to implement practices detailed in conservation plans. A landowner's cost may be reimbursed up to 100 percent for no longer than 3 years for various land management practices. These practices include management of nutrients, manure, and wildlife habitat or irrigation water. Landowners' costs for conservation practices such as filter strips, grassed waterways, and wildlife may be reimbursed up to 75 percent.

Farmland Assessment Act of New Jersey

To preserve open space, the people of New Jersey passed the Farmland Assessment Act of 1964, to be administered by the New Jersey Forest Service. The Act was amended in 1986, requiring woodland owners with 5 acres or more of woodlands to develop and implement a State-approved forest management plan written by an approved forester to qualify for reduced property taxation. Under the current Farmland Assessment Program, woodland owners, in addition to the forest management plan, must also have annual gross sales of forest products averaging $500 for the first 5 acres, plus $0.50 for every additional acre. The woodlands must be actively devoted to carrying out the forestry recommendations as prescribed in the approved forest management plan. To ensure that woodland owners are complying with the law, the New Jersey Forest

Service is required to inspect each woodland every 3 years. The Farmland Assessment Act has been successful in preserving open space and protecting privately owned woodlands.

Farmland Preservation Program of New Jersey

The Farmland Preservation Program is administered by the New Jersey State Agriculture Development Committee (SADC), which coordinates with County Agriculture Development Boards, municipal governments, nonprofit organizations, and landowners in the development of plans that best meet the needs of individual landowners. The program targets the purchasing of woodlands and farmlands, especially stewardship properties being managed for environmental benefits and is limited to owners of farmland. Farms or development easements that are acquired through the Farmland Preservation Program will forever be protected for agricultural use. The SADC also provides grants to counties, municipalities, and nonprofit groups to fund the purchase of development easements; directly acquires farms and development easements; and offers grants to landowners in the Farmland Preservation Program to fund up to 50 percent of the cost of soil and water conservation projects. It also administers the Right to Farm Program, oversees the Transfer of Development Rights Bank, and operates the Farm Link Program—which matches farm sellers with potential buyers.

Farmland Protection Program of New York State

The New York State Department of Agriculture and Markets administers two matching grant programs focused on farmland protection. The first program was designed to assist county governments in developing agricultural and farmland protection plans to maintain the economic viability of the State's agricultural industry and its supporting land base. The second program was established to assist local governments in the implementation of local farmland protection plans that focus on preserving the land base by purchasing the development rights on farms using a legal document called a conservation easement. Agricultural conservation easements must be held, monitored, and enforced in perpetuity. State assistance payments for farmland protection projects may be authorized under the New York State Environmental Protection Fund to cover up to 50 percent of the costs for counties to develop agricultural and farmland protection plans, and up to 75 percent of the costs for the purchase of development rights on farms.

WETLAND RESOURCE ASSISTANCE PROGRAMS

Wetlands Reserve Program

The USDA Natural Resources Conservation Service administers and delivers Wetlands Reserve Program. The primary objective of the program is to provide technical and cost-share assistance for the voluntary removal of marginal agricultural lands from production in order to restore and protect them as wetlands. The three eligibility options for program enrollment are permanent easement, 30-year easement, and restoration cost-share agreement. The restoration cost-share requires a minimum commitment of 10 years. The benefits received by an enrolled landowner depend on the program option. Permanent easement for wetland restoration pays up to 100 percent of the cost. A 30-year easement pays 75 percent of the cost. If the landowner enters into a restoration cost-share agreement, no reimbursement is offered for protection of the wetland restoration site, but 75 percent of the wetland costs are reimbursed.

WILDLIFE ASSISTANCE PROGRAMS

Harbor Estuary Program

The U.S. Environmental Protection Agency established the New York – New Jersey Harbor Estuary Program in 1988 out of a growing public concern for the health of the New York – New Jersey Harbor and Bight ecosystem, and designated the estuary an "Estuary of National Significance." The Harbor Estuary Program focuses on the following issues: habitat loss and degradation, toxic compounds, dredge material management, pathogens, nutrients and organic enrichment, and floatable debris. The program pulled together representatives from the private and public sectors, including government, industry, business, and environmental interest groups, as well as elected officials from counties in the area into a partnership known as the Management Conference. The mission of the conference was to develop a plan to protect and restore the estuary. Large portions of the New Jersey Highlands and a small part of the New York Highlands are part of the New York – New Jersey Harbor Study Area Program. The Harbor Estuary Program could serve as a model for protecting portions of the Highlands as an area of national significance through a partnership effort.

Partners for Fish and Wildlife

The U.S. Fish and Wildlife Service's Partners for Fish and Wildlife Program provides funding for voluntary habitat restoration in cooperation with private landowners. This program could be particularly effective in the Highlands, where large portions of open space lands are in private ownership. This voluntary cost-share program's goals are to protect, enhance, and restore important fish and wildlife habitats on private lands through partnerships. In New York and New Jersey, this program has restored wetlands and grasslands, and several threatened and endangered species habitats.

APPENDIX I RESOURCE ASSISTANCE PROGRAMS

In New Jersey, the Bring Back the Natives Program, administered through the Partners for Fish and Wildlife Program, is a cooperative effort between the National Fish and Wildlife Foundation, U.S. Fish and Wildlife Service, Bureau of Land Management, USDA Forest Service, Bureau of Reclamation, and Trout Unlimited, to restore native aquatic species and their habitats through local and regional partnerships. The U.S. Fish and Wildlife Service's New Jersey Field Office implements this program throughout New Jersey and in the Highlands region. Under Bring Back the Natives, the National Fish and Wildlife Foundation matches Federally funded challenge grants with contributions from private foundations, corporations, individuals, State and local governments, and nonprofit organizations for conservation projects.

Wildlife Habitat Incentives Program

The objective of the USDA Natural Resources Conservation Services' Wildlife Habitat Incentives Program (WHIP) is to provide technical and cost-share assistance to establish and enhance wildlife and fish habitat. Eligibility for the WHIP is fairly broad as long as landowners can demonstrate ownership or control of the land they want to enroll. A wildlife habitat plan must be developed and implemented over a 5- to 10-year period. WHIP will pay up to 75 percent of the landowner's cost of installing wildlife habitat practices recommended in the wildlife habitat development plan. New wildlife practices may be implemented with cost-share payments, or the payments may be used to replace practices that failed for reasons out of the landowner's control. A maximum of $10,000 can be paid to defray costs per contract. The landowner also receives a professionally prepared wildlife habitat development plan with recommendations to improve wildlife habitat on their land.

MULTIPLE RESOURCE ASSISTANCE PROGRAMS

"Cooperative Extension" Program

The Cooperative State Research, Education, and Extension Service (Cooperative Extension) provides a link between research developed at universities and delivers this knowledge to local communities. Cooperative Extension operates nationwide through each State's land grant university. In New Jersey, the land grant university is Rutgers University. In New York, the land grant university is Cornell University. Cooperative Extension has forestry extension and research programs, and competitive grants programs available to communities across the country. In New York State, Cornell Cooperative Extension improves quality and sustainability of human environments and natural resources through an Environmental Outreach Council and a Water Quality Programming Project. In New Jersey, Rutgers Cooperative Extension helps consumers, agriculture, and other businesses develop and implement practices that maintain a balance among the environment, human health, and economic benefits, through a Pest Management Office, Harmful Plants Gallery, and a Drought Web site. All of these programs are available to Highlands residents and organizations.

Resource Conservation and Development Program

USDA Natural Resources Conservation Service administers the Resource Conservation and Development (RC&D) Program, initiated in 1962 to help people care for and protect their natural resources to improve an area's economy, environment, and living standards. The program provides a way for local residents to work together and plan how they can actively solve environmental, economic, and social problems facing their communities. The program consists of 277 authorized RC&D areas nationwide (two in New Jersey and one in New York) that deliver coordinated resource conservation and rural development assistance to communities around the county. RC&D pulls together communities, various units of government, and grassroots organizations and helps them to establish direction for the local program.

The North Jersey RC&D Council operates in several communities of the New Jersey Highlands region. The Council facilitates the protection of the region's human and natural resources by working with communities and regional partnerships to do the following: address issues related to water quality, water resource protection, and sustainable farming; build local community capacity; and manage natural hazards that impact community planning. Staff at the North Jersey RC&D Council have coordinated and implemented riparian forest buffer programs in 20 watersheds; provided technical assistance to farmers; assisted local communities with project start-up, coordination and training for regional initiatives; and acted as regional coordinator of watershed management, characterization, and assessment for the Upper Delaware watershed.

Rivers, Trails and Conservation Assistance Program

The Rivers, Trails and Conservation Assistance Program is an outreach program of the U.S. Department of Interior's National Park Service that provides technical assistance to help local groups plan greenways, conserve rivers and watersheds, and develop new trails through voluntary partnerships that emphasize local initiatives and involvement. The National Park Service lends skills in planning, design, and organizing to a community. Rivers, Trails and Conservation Assistance works in partnership with landowners, local business owners, agencies, and private groups. Program staff helps to define goals, resolve issues, and reach agreement on how important areas should be improved and protected. This program could be particularly useful to local communities in planning for protection of the conservation focal areas identified in the Conservation Values Assessment of the Highlands study update.

Wild and Scenic Rivers Act

The National Park Service's Wild and Scenic Rivers Act (1968) established a program that preserves selected rivers in their free-flowing condition, to protect water quality and to fulfill other vital national conservation purposes. The program provides a model for regional conservation and resource protection. The goal is to preserve the character of a river as a "living landscape," where uses compatible with the management goals of a particular river are allowed and where change is expected to happen.

Three sections of the Musconetcong River, the only river in New Jersey that falls entirely within the Highlands, have been determined eligible for designation under the Wild and Scenic Rivers Program. The National Park Service and the Musconetcong Watershed Association have sought and gained resolutions of support from the municipalities within the river corridor as well as from the four counties that fall within the Musconetcong watershed. The Musconetcong is expected to receive Wild and Scenic status by December 2003, which would make it one of only three New Jersey rivers to achieve this designation.

An example of a designated Wild and Scenic River outside the Highlands region is a nearby 67-mile stretch of the Lower Delaware River along the border of eastern Pennsylvania and western New Jersey, which includes three Pennsylvania tributaries. The river's designation as a Wild and Scenic River is the result of a cooperative effort between the National Park Service and the Delaware River Greenway Partnership. Similar to the Highlands region, the lower Delaware River region contains immense resource diversity, with a high population density and a wealth of natural, cultural, and historical resources and recreational opportunities

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FIRE ASSISTANCE PROGRAMS

Volunteer Fire Assistance Program

The purpose of the Volunteer Fire Assistance Program, formerly known as the Rural Community Fire Protection Program, is to provide Federal financial, technical, and other assistance to State Foresters and other appropriate officials to organize, train, and equip fire departments in rural areas and rural communities, to prevent and suppress wildland fires. A rural community is defined as having a population of 10,000 or less. This population limit for participation in the Volunteer Fire Assistance Program facilitates distribution of available funding to the most needy fire departments. More than 500,000 volunteer firefighters serve and protect rural residents nationwide. Volunteer Fire Assistance Program funds are provided to the State forestry agencies through the USDA Forest Service, and most grants are $5,000 or less.

Appendix J

History of Conservation Successes in the Highlands

1. 1937 – Palisades Interstate Park Commission (PIPC) established

The commission was established by bi-State compact and approved by the U.S. Congress. This bi-State agency could participate in land acquisition and land management in the New York – New Jersey metropolitan region (see item 12).

2. 1961 – New Jersey Green Acres Program established

The Green Acres Program was created to meet New Jersey's growing recreation and conservation needs. Since its inception, 74,900 acres have been protected and $170 million has been spent through State acquisition, 25,000 acres have been protected and $130 million spent through local programs, and 4,000 acres have been protected and $12 million spent through nonprofit programs in the Highlands.

3. 1989 – Skylands Greenway Task Force created

New Jersey Governor Kean signed Executive Order 224 creating a Skylands Greenway Task Force to identify a greenway. Included were names of the jurisdictions managing certain natural resources, an inventory of all public and private land, and actions needed to implement the greenway (see items 8, 9).

4. 1990 – New York – New Jersey Highlands Study authorized

Congressman Kostmayer (PA) included the Sterling Forest Provision in the 1990 Farm Bill (HR 3950), authorizing a study of the New York – New Jersey Highlands, located in the States of New York, New Jersey, and Pennsylvania, including the Sterling Forest in Orange County, NY (see item 7).

5. 1991 – Hudson River Valley Greenway Act

The Hudson River Valley Greenway includes portions of the New York Highlands, and is a State-sponsored program created to develop a voluntary regional strategy for preserving scenic, natural, historic, cultural, and recreational resources while encouraging compatible economic development.

6. 1992 – The New Jersey Highlands: Treasures at Risk report released

The New Jersey Conservation Foundation released a report that provides a natural resources inventory of the Highlands (see item 14).

7. 1992 – New York – New Jersey Highlands Regional Study published

The USDA Forest Service completed this study as provided by the 1990 Farm Bill. The study supported land stewardship and watershed-based planning activities; identified conservation easements and land purchases as a voluntary, nonregulatory means to protect important areas; fostered citizen-level awareness of the region's natural resources; and identified priority conservation areas for protection and management (see items 9, 21).

8. 1992 – Skylands Greenway: A Plan for Action report released

The Skylands Greenway Task Force was created by Executive Order 224 in New Jersey. It recognized the need for a regional planning entity and improvements to land use planning and natural resource management in the Highlands. It called for the designation of a Highlands National Stewardship Area, and the establishment of a Federally authorized Highlands Regional Council (see item 9).

9. 1992 – The New York – New Jersey Highlands Work Group Report released

The Highlands Work Group, chaired by Christopher Daggett, former New Jersey Department of Environmental Protection Commissioner, and staffed by Regional Plan Association (RPA) with the assistance of the USDA Forest Service, was created in spring 1992 when the former members of the New York – New Jersey Highlands Regional Study, the Skylands Greenway Task Force, and other interested citizens joined together to promote swift and concerted public action to protect the Highlands of New York and New Jersey. The report called for the designation of a Highlands National Stewardship Area in cooperation with the USDA Forest Service, and the establishment of a Federally authorized Highlands Regional Council within the stewardship area (see item 25).

10. 1993 – Highlands Trust Advisory Board created

New Jersey Governor Florio signed Executive Order 82 creating the Highlands Trust Advisory Board to make recommendations on lands most suitable for preservation, as well as to examine efforts to identify natural habitats, greenway corridors, cultural resources, scenic roads, and landscapes.

11. 1993 – Morris County, New Jersey Open Space Farmland and Preservation Trust Fund established

Morris County's open space acquisition funding program has led to the acquisition of 7,000 acres, and has spent $47 million in the Highlands since 1993. The purchase of 3,400 acres is pending, and nearly $20 million are encumbered for future land acquisitions. As of June 2002, all seven New Jersey Highlands counties offer an open space funding program for land acquisition.

12. 1995 – Jurisdiction of PIPC expanded

New Jersey S137 acknowledged the importance of the Highlands Region by expanding the jurisdiction of the Palisades Interstate Park Commission, so that this bi-State agency could participate in land acquisition and its management within this region (see item 15).

13. 1995 – Hudson Highlands Lands acquired

Since 1995, New York has acquired 26,777 acres in the Hudson Highlands area, which includes the 794-acre Wonder Lake State Park (Putnam County), 5,197 acres of additions to Clarence Fahnestock State Park (Putnam County), 2,458 acres to create Schunemunk Mountain State Park (Orange County), a 53-acre addition to High Tor State Park (Rockland County), and 231 acres of additions to Hudson Highland State Park (Putnam County). New York used $9,515,000 in Environmental Bond Act funds and $16,410,000 in Environmental Protection Fund dollars for these acquisitions.

14. 1996 – RPA Third Regional Plan—A Region at Risk and Building a Metropolitan Greensward released

The Regional Plan Association plan identifies the Highlands as one of 12 region-shaping open spaces and calls for its conservation. "The Treasures of the Highlands" lists the top 12 critical sites out of about 75 originally identified through a survey of Highlands Coalition members and public officials.

15. 1997 – Sterling Forest Park purchased

New Jersey S1672 provided funds to the Palisades Interstate Park Commission (PIPC) to purchase Sterling Forest in New York and New Jersey. Approximately 20,000 acres have been protected since 1990 with the following funding: 2,000 acres purchased for $9.2 million in 1990; 15,280 acres purchased for $55 million in 1998; 1,350 acres purchased for $7.89 million in 2000; 659 acres purchased for $860,000 in 2000; and 209 acres purchased for $610,000 in 2000.

16. 1997 – New York City Watershed Memorandum of Agreement signed

This agreement unites watershed communities, including portions of the New York Highlands, New York City, New York State, the U.S. EPA and environmentalists in support of an enhanced watershed protection program for the New York City drinking water supply. The Agreement defines the three elements of this watershed protection program, including land acquisition and stewardship, watershed protection and partnership, and watershed regulations.

17. 1997 – New Jersey's Watershed Management Area Planning begun

Twenty watershed management areas are being studied in New Jersey through grants provided by the New Jersey Department of Environmental Protection from its Watershed Protection Fund. The projects began in 1999 and 2000, and were

to have a 4-year life. The projects have two phases: Phase 1 is characterization and assessment, and Phase 2 is planning, which will develop a watershed area management plan. Five watershed management areas include lands within the Highlands region. The Department of Environmental Protection is reassessing the program to determine the extent to which the overall approach should be modified.

18. 1998 – New York State Farmland Protection Program established

Approximately 6,500 acres of productive farmland have been protected in the New York Highlands.

19. 1999 – Highlands Trail designated a Millennium Legacy Trail

The Highlands Trail project was begun in 1995 with the assistance of the National Park Service and the New Jersey Conservation Foundation. It is a cooperative effort of the New York – New Jersey Trail Conference, conservation organizations, State and local governments, and local businesses. When completed, the trail will extend over 150 miles from Storm King Mountain on the Hudson River in New York south to Phillipsburg, New Jersey, on the Delaware River. The Millennium Legacy Trail designation is one of only 50 in the United States, giving it singular status among New Jersey's natural and historic pathways, in addition to making it eligible for extensive financial aid.

20. 1999 – Establishment of a Highlands National Forest requested

Sponsored by Assemblyman Paul DiGaetano, New Jersey Assembly Joint Resolution No. 76 requested the President and Congress to establish Highlands National Forest in New Jersey and to provide for its administration and management as a "Preserve."

21. 2000 – Update of New York – New Jersey Highlands Regional Study authorized

Federal legislation sponsored by Senator Torricelli and Congressman Frelinghuysen provided $750,000 to update the 1992 New York – New Jersey Highlands Regional Study (see item 26).

22. 2000 – First Highlands Preservation Summit convened

Congressman Gilman (NY) convened the first Highlands Preservation Summit, leading to the establishment of a Highlands Preservation Initiative Working Group in 2001. Its purpose is to draft Federal legislation to protect the environmentally sensitive areas, historical heritage, and biodiversity of the Highlands, while ensuring economic prosperity and opportunity for the States, counties, municipalities, and businesses in this region (see item 12).

23. 2001 – New Jersey State Plan recognized Highlands

The New Jersey Planning Commission identified the New Jersey Highlands as the first Special Resource Area in the State. A Special Resource Area is a region with unique characteristics or resources of Statewide importance that are essential to the sustained well-being and function of its own region and other regions, and to quality of life. The State Plan recommends several planning and implementation strategies in the Highlands.

24. 2001 – New York Open Space Plan identified Highlands

The New York State Department of Environmental Conservation's Open Space Plan identifies the Highlands as a unique physiographic region. The plan recommends developing a greenway corridor comprised of State parks, forests, and other lands that span the length of the New York Highlands. In addition, the Department of Environmental Conservation's Hudson River Valley Biodiversity Manual cites the need for additional inventory work to prevent continued conversion and fragmentation of Highlands area forests and wetlands.

25. 2002 – Highlands Stewardship Act introduced

Congressman Gilman introduced this bill to Congress. It recognizes the national significance of the Highlands region by defining it as the nation's first "Stewardship Area." The measure is broken into two provisions: Land Conservation and the Office of Highlands Stewardship. The land conservation provision will ensure funds for land preservation purposes. The Office of Highlands Stewardship is designed to provide technical and financial assistance to States, communities, and private landowners—including farmers and individuals.

26. 2002 – New York – New Jersey Highlands Regional Study: 2002 Update completed

The USDA Forest Service Highlands Study update provides comprehensive, updated information on the land, water, and people of the region; detailed analyses of watershed condition, forest fragmentation, and biological diversity; identifies focal areas for protection and management; and outlines potential conservation strategies. A separate technical report, to be available on compact disc and through a Web site, provides more detailed information (methodology, data files, maps) on the study update.

Appendix K

Land Conservation Projects

To help demonstrate how information on the regional importance of Highlands resources can help shape positive local decisions, the USDA Forest Service funded the Land Conservation Projects Program. This program, undertaken through the offices of the Regional Plan Association, provided matching funds for pilot initiatives in New Jersey and New York communities that would demonstrate these program goals:

- Encourage the local use of comprehensive resource information, especially information regarding regional values or characteristics of natural resources in the Highlands.
- Promote collaborative land use decisionmaking and natural resource management, including cooperation among localities, among localities and State and regional agencies, and among government and private individuals and organizations.

The need for such a program has been documented many times, including in the listening sessions conducted in spring 2001 as part of the resource assessment for the Highlands study update.

Municipal and county governments, State and local park agencies, land trusts and other nonprofit organizations and private landowners were eligible for the grants. Thirteen applications totaling $280,000 were received. Through a competitive process, $90,000 was allocated to these four projects on a 50/50 cost-share basis:

- Updating the Comprehensive Plan and Zoning Ordinance for Philipstown, New York;
- Regional Greenway Plan for Southeastern Sussex County, New Jersey;
- Conservation Initiative for the Watersheds of Spruce Run Reservoir in New Jersey; and
- Setting the Standards for Water Quality Protection in the Highlands (Morris County, New Jersey)

This appendix describes these four projects (Figure K-1). They demonstrate how local government, private water purveyors, and nonprofit organizations can use the resource assessment in this report and similar Geographic Information System (GIS) information to protect drinking water and recreational resources, and to reconcile local and regional needs and responsibilities for conservation and development. Completion of the specific projects is expected by spring 2003; however, the overall program will continue to be a model for how the USDA Forest Service and other entities can provide financial and technical resources to Highlands communities to help safeguard regional resources.

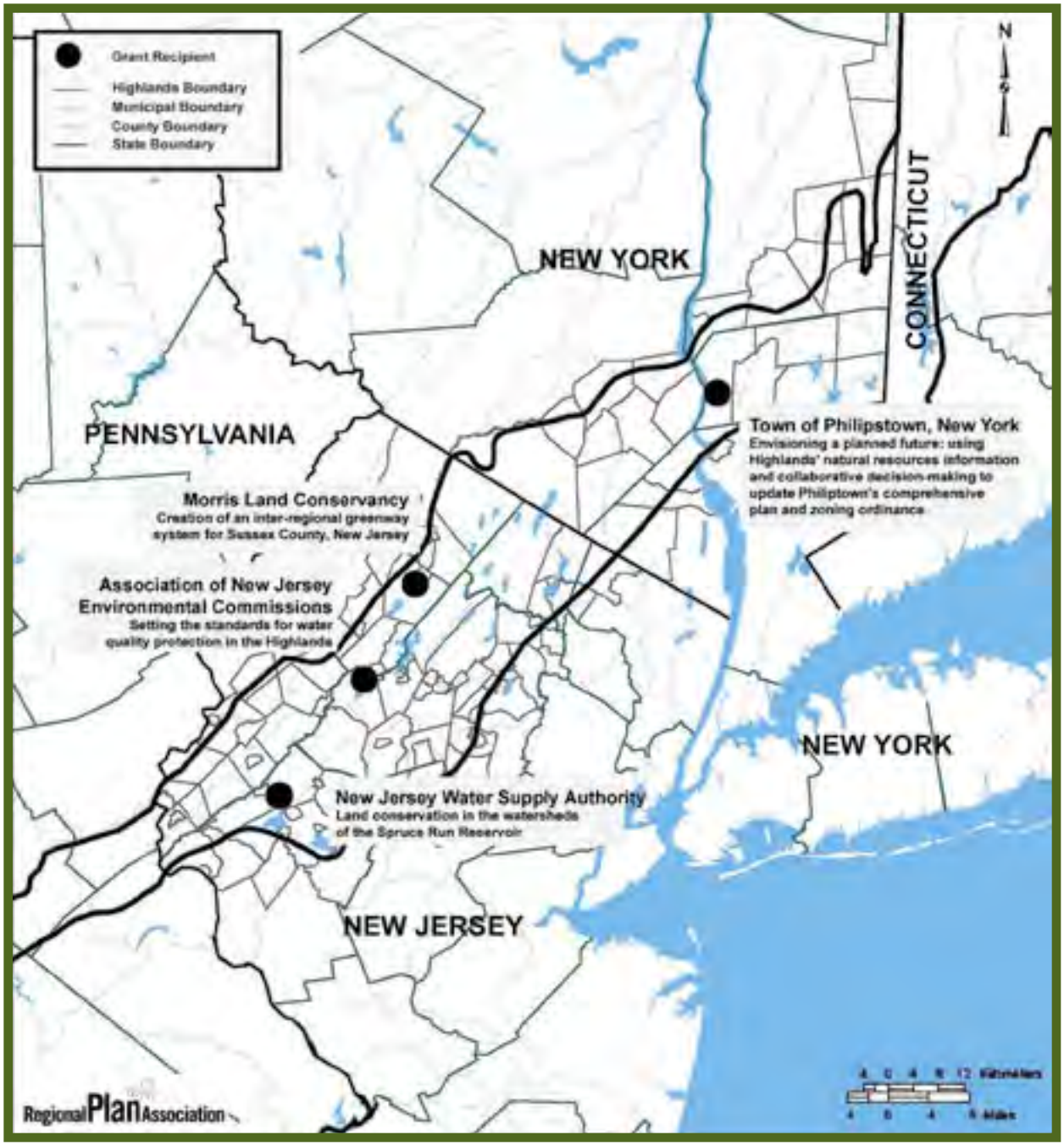
Grant Recipient
Highlands Boundary
Municipal Boundary
County Boundary
State Boundary
N
NEW YORK
CONNECTICUT
PENNSYLVANIA
Town of Philipstown, New York
Envisioning a planned future: using Highlands' natural resources information and collaborative decision-making to update Philiptown's comprehensive plan and zoning ordinance
Morris Land Conservancy
Creation of an inter-regional greenway system for Sussex County, New Jersey
Association of New Jersey Environmental Commissions
Setting the standards for water quality protection in the Highlands
NEW YORK
New Jersey Water Supply Authority
Land conservation in the watersheds of the Spruce Run Reservoir
NEW JERSEY
Regional Plan Association

Figure K-1. Land conservation projects. Four projects being administered by the Regional Plan Association received USDA Forest Service grants. These projects show how the information in this Highlands study update and collaborative decisionmaking can be used to meet local needs and to protect regionally important resources.

Updating the Comprehensive Plan and Zoning Ordinance for Philipstown, New York

Project Sponsor: Town of Philipstown
Project Location: Town of Philipstown, Putnam County, New York

Philipstown is engaged in a comprehensive planning process. A special board of 15 residents was convened in early September 2001 and was charged with preparing the Comprehensive Pan. The Board has been meeting regularly, with a target completion date of March 2003.

The Land Conservation Project grant ensures that the comprehensive resource information presented in the Highlands resource assessment as well as other data from a variety of partners will be used to inform the update of Philipstown's Comprehensive Plan and zoning ordinance. To encourage collaborative decisionmaking, town-wide planning forums and educational information sessions will continue throughout the drafting of the Comprehensive Plan and the revising of land use policies and zoning ordinances. The data gathering and GIS mapping is being managed for the Town by the Hudson Highlands Land Trust, a nonprofit organization based in Philipstown.

The resource assessment, as well as information from The Nature Conservancy, make it clear that Philipstown has forests that are a significant part of the Highlands region. Other important information has been gathered from Putnam County, the Hudson River Greenway Conservancy, the New York – New Jersey Trail Conference, The Open Space Institute, and Scenic Hudson Land Trust.

The open space work group of the special board is defining a process to formulate conservation goals. Natural resource features are being characterized as serving one of four functions: public health (water quality), community character, recreation and habitat. The work group is using GIS maps of these features and functions to get a better grasp of the natural resources in town to identify how to preserve them, and to determine needed changes to zoning and land use regulations. The entire special board will draft implementation measures that integrate the comprehensive plan objectives.

Expected final products include a comprehensive plan update showing open space priority areas, as well as large-scale GIS maps showing Philipstown's natural resource features, including steep slopes, aquifers, wetlands and waterways, hiking trails, habitats, current zoning, remaining undeveloped large tracts, preserved lands, and elements required by law (Figure K-2).

One of the important outcomes of this project will be how to balance conservation of natural resources within the framework of a comprehensive plan. Because the work is being done as part of a broader community-based vision, this Land Conservation Project takes into account other community objectives, such as affordable housing and commercial development. The success of this project will rely on presenting an integrated plan to the community that addresses the broad array of issues.

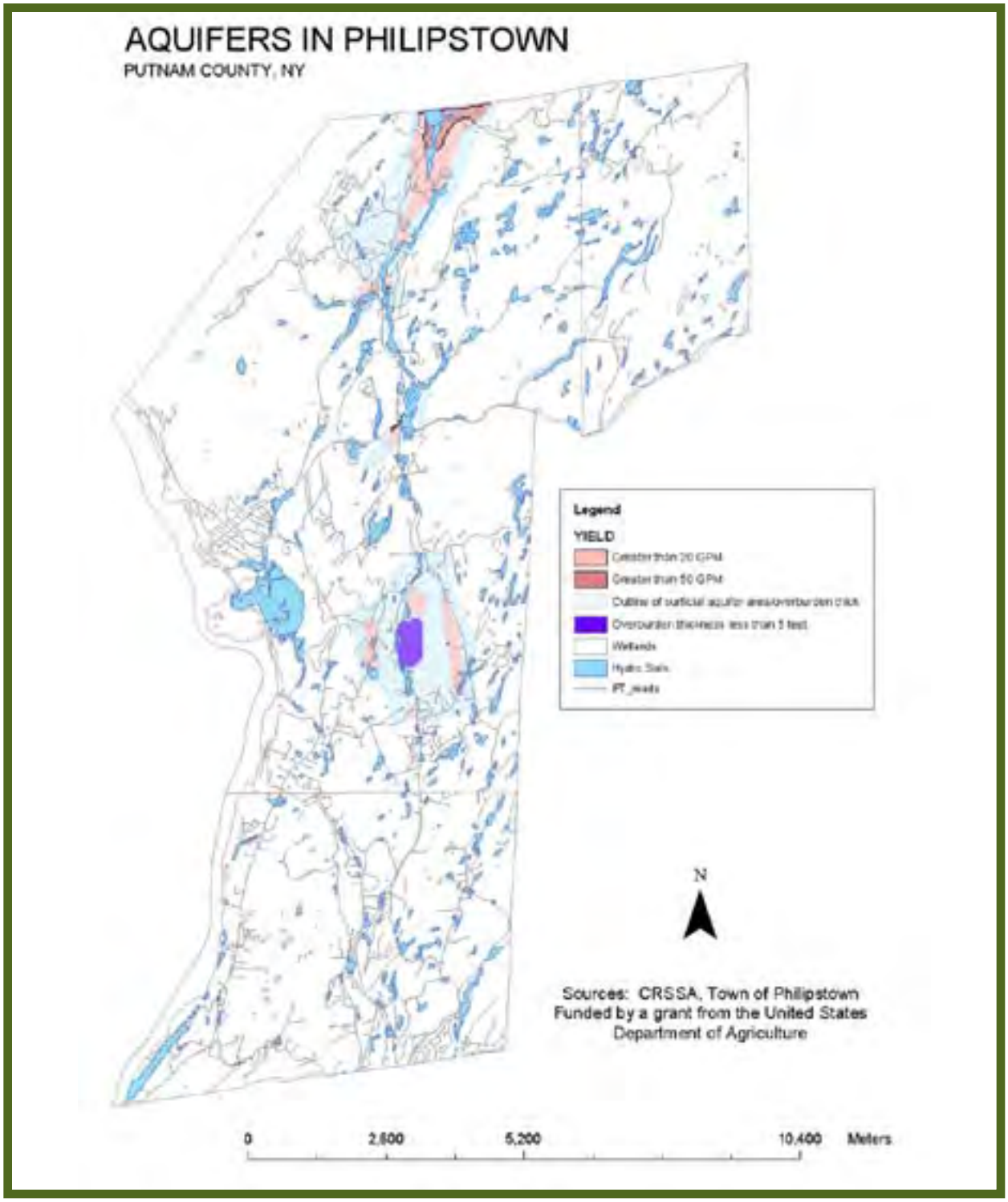

Figure K-2. Water resources in Philipstown. Water quality is one of the natural resource functions that will be addressed in conservation goals for Philipstown, Putnam County, New York.

REGIONAL GREENWAY PLAN FOR SOUTHEASTERN SUSSEX COUNTY, NEW JERSEY

Project Sponsor: Morris Land Conservancy
Project Partner: Rutgers University Center for Remote Sensing and Spatial Analysis
Project Location: Byram, Sparta and Andover Townships, Hopatcong, Stanhope and Andover Boroughs (Sussex County, New Jersey)

Morris Land Conservancy and the Department of Landscape Architecture at Rutgers University jointly prepared a plan creating a system of open space linking Byram, Hopatcong, Stanhope, Sparta, Andover Township, and Andover Borough. Titled the "High Lakes Greenway," the plan started with the Lubbers Run Greenway, a centerpiece of the open space program in Byram Township. Recent land conservation work in Byram Township has led to a municipal Open Space and Recreation Plan and township-wide trail map. The township is pursuing permanent preservation of a riparian corridor along the banks of Lubbers Run to link the town's neighborhoods, scenic areas, and recreation and municipal facilities.

Morris Land Conservancy met with local planning boards, governing bodies, and administrative staff to present the regional greenway vision and identify the individual towns' significant natural features, sites, and priorities for open space preservation and land acquisition. Local land trusts, State park managers, and trail groups were also contacted for project areas and land acquisition priorities. Using both the local information and Statewide data available through the Center for Remote Sensing and Spatial Analysis at Rutgers University, the students identified critical areas and developed a site inventory of the six communities in the study.

Using the CEDAR greenway analysis from the Green Space Design Institute, the students mapped the cultural, ecological, developmental, agricultural, and recreational (CEDAR) components of the six communities on one map. Overlaying the priorities of the local communities (trail connectivity and protection of water resources), the students created overall greenway designs linking the six communities (Figure K-3). The greenway vision demonstrates how open space can act as a system to preserve sensitive water supplies and provide corridors between communities. The natural resources and priorities for each town form the basis of the greenway plan and will guide the recommendations of the final report.

The report and summary brochure outline ways local governments can use their master planning and zoning to work with private and public landowners to protect their forest land and conserve natural resources. Involvement of the local communities in this important region of New Jersey is critical to the preservation of sensitive environmental corridors.

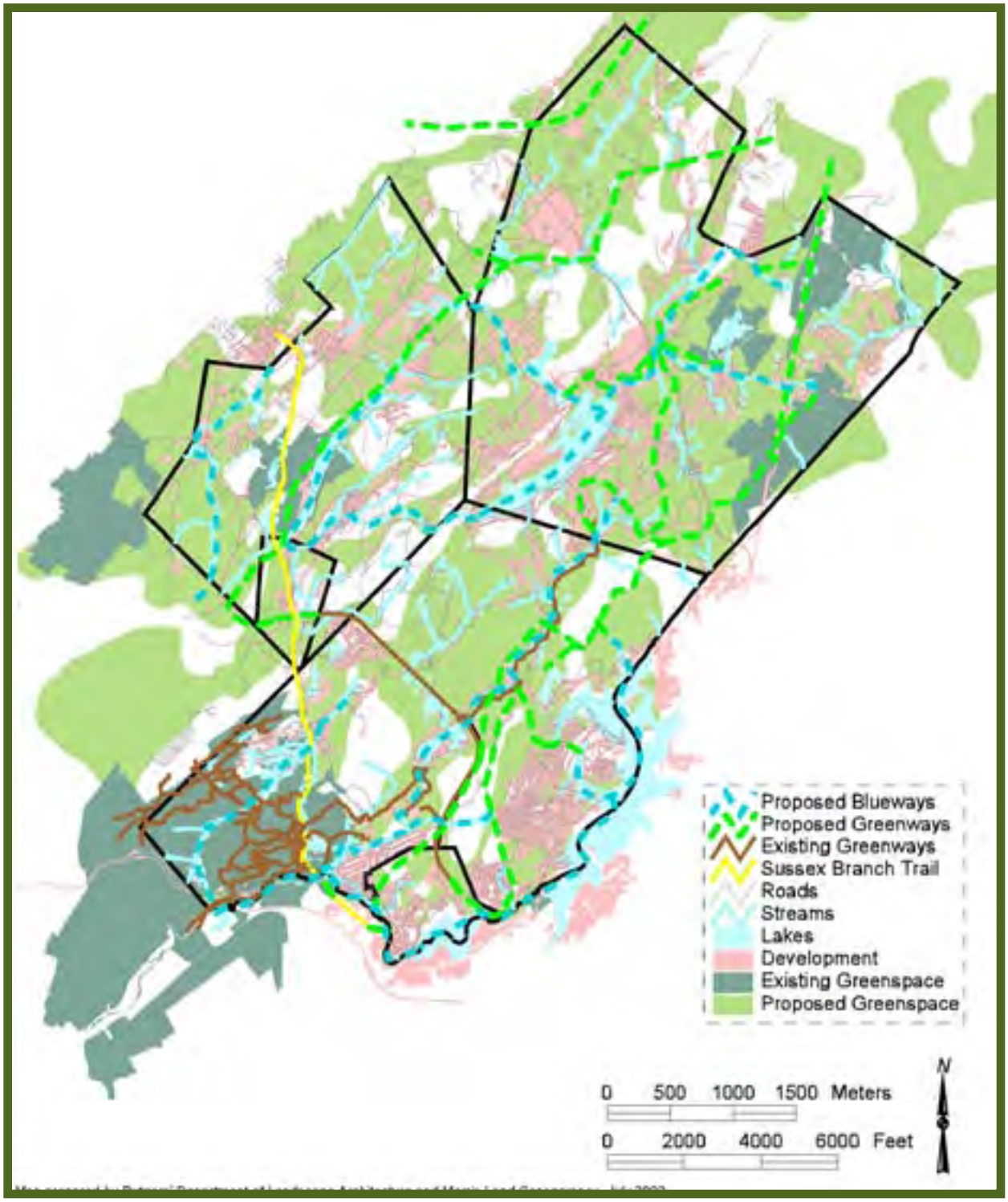

Figure K-3. Morris Land Conservancy's greenways and blueways. The greenways proposed for the High Lakes Greenway in Sussex County, New Jersey, would provide open space corridors between communities, and blueways would preserve sensitive water supplies.

APPENDIX K LAND CONSERVATION PROJECTS

CONSERVATION INITIATIVE FOR THE WATERSHEDS OF SPRUCE RUN RESERVOIR IN NEW JERSEY

Project Sponsor: New Jersey Water Supply Authority
Project Partners: New Jersey Department of Environmental Protection–Division of Parks and Forestry, New Jersey Department of Environmental Protection–Division of Fish and Wildlife, Hunterdon County Planning Department, the South Branch Watershed Association, and the six local municipalities
Project Location: Bethlehem, Lebanon and Union Townships, Glen Gardner and High Bridge boroughs, and Washington Township (Hunterdon and Morris counties, New Jersey)

The New Jersey Water Supply Authority operates the Spruce Run Reservoir, a critical part of the Raritan Basin water supply system and the only reservoir in the State that is fed directly and solely by natural streamflow. Due to increasing development in the area, wastewater levels have increased, water-supply carrying capacity is under stress, and nutrient levels in the Spruce Run Reservoir are rising.

The Spruce Run Initiative is an effort to permanently protect the Spruce Run Reservoir and to reverse existing stresses as much as possible. The initiative includes land acquisition, land management, and remedial efforts, and will take several years to complete.

Under the Land Conservation Project, the New Jersey Water Supply Authority will satisfy one component of the initiative by working with local governments to accomplish the following:

- Identify land acquisition targets,
- Coordinate land development activities to increase ecological value of dedicated open space from clustered development,
- Identify appropriate changes to municipal zoning and development ordinances in the reservoir watershed, and
- Educate the general public and government officials about the process, rationale, and results of the initiative.

The townships of Bethlehem, Lebanon, and Union, and the boroughs of Glen Gardner and High Bridge have adopted Memoranda of Understanding with the Water Supply Authority for their involvement in the Spruce Run Initiative. Funds are being provided from the Land Conservation Project grant to the three townships so that their professional planners can be involved in the process. All three townships have authorized this activity. Through May 2002, the municipalities' planners provided detailed information on current zoning and ordinances relating to natural resource conservation issues such as clustering, as well as recent development not shown on New Jersey Department of Environmental Protection's land use/land cover maps. Land use in the Spruce Run watersheds in 1995 is shown in Figure K-4. The Water Supply Authority selected Morris Land Conservancy, an open space planner, to provide expert support to the process. Meetings have focused on development of open space priorities using an interactive GIS-based process.

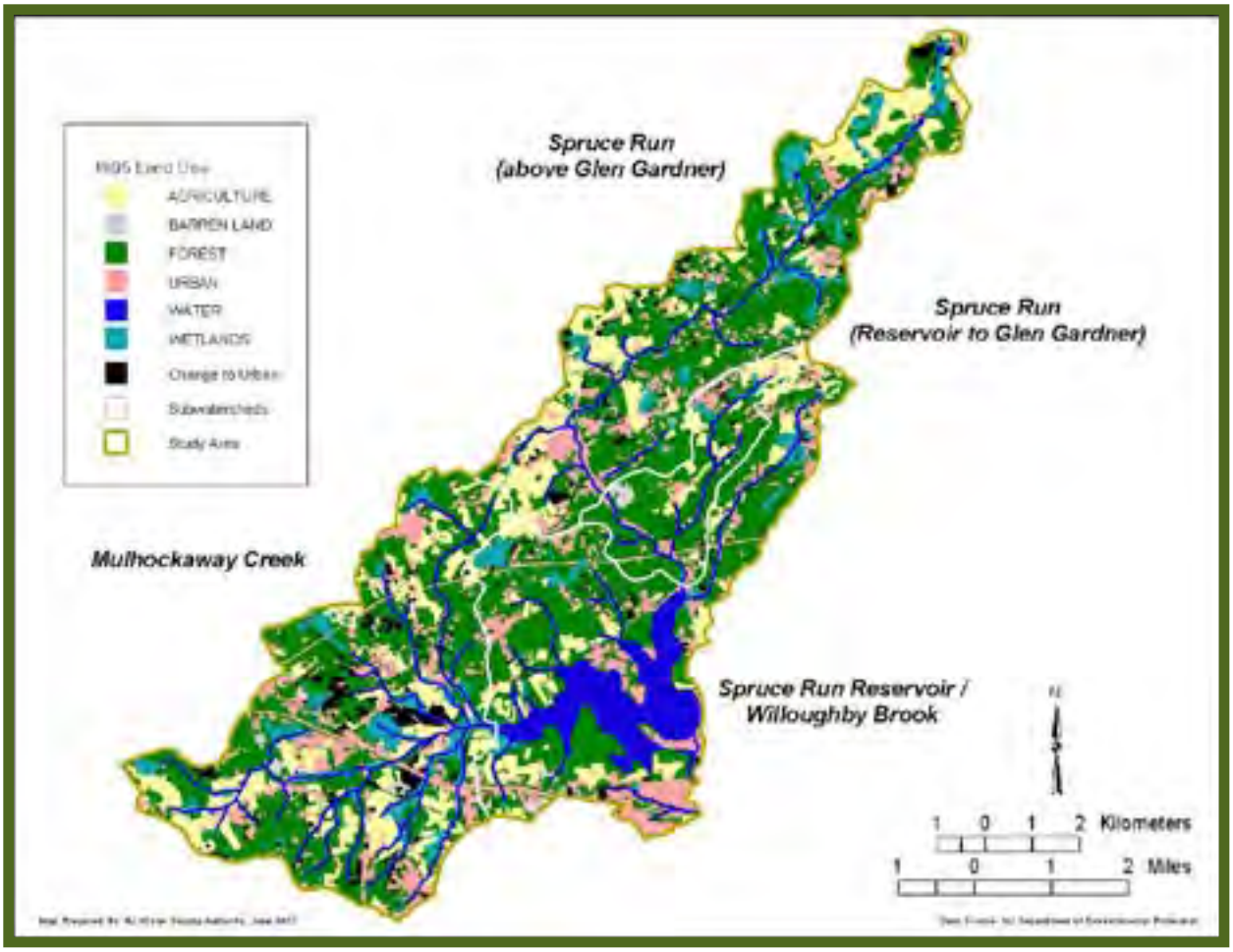

Figure K-4. Study area for the Spruce Run Initiative. Increasing urban development in the Spruce Run watersheds in Hunterdon and Morris Counties, New Jersey, is having a negative effect on water quality. Land use is shown for 1995.

The Spruce Run Initiative members developed a Critical Areas Preservation Plan, incorporating both acquisition priorities and subdivision control measures to ensure the maximum contiguity and extent of permanent forest cover in the watersheds. Six large concentrations of undeveloped lands have been targeted for preservation efforts in the watershed. If all parcels could be preserved, dedicated open space in the watershed would increase by approximately 5,800 acres, more than doubling the existing amount. To the extent that targeted parcels are developed, the plan specifies methods of ensuring preservation of as many critical features on those properties as possible. Finally, the plan identifies some useful additions to existing land use ordinances to preserve critical areas.

SETTING THE STANDARDS FOR WATER QUALITY PROTECTION IN THE HIGHLANDS

Project Sponsor: Association of New Jersey Environmental Commissions (ANJEC)
Project Location: Mount Olive and Roxbury Townships, Morris County, New Jersey

The purpose of this project was to assess the impacts of development on headwaters of the Raritan River, identify the critical factors in water quality degradation, and develop the methods and derive the standards and sample ordinances to protect potable water supply and aquatic habitat environments. The project assessed watershed conditions and resulting impacts on biological diversity.

In addition to the Land Conservation Project grant, this project was also supported with volunteer staff and in-kind services from the Environmental Commissions of Mount Olive and Roxbury townships.

This project focused on the aquifer system underlying Budd Lake in Mount Olive and the Drakes Brook watershed in Mount Olive and Roxbury (Figure K-5). Both areas are under intensive development pressure, and the depletion and degradation of the aquifer system and watershed are concerns. They are also representative examples of Highlands geology, water supply, and development patterns.

Budd Lake is a major recreational resource located in Mount Olive Township. The lake is surrounded by development that depends on a regional aquifer system consisting of surficial glacial material, limestone formations, and granitic bedrock for its water supply.

Drakes Brook runs from Mount Olive into Roxbury Township. It is a trout maintenance stream that is upstream of trout production streams, potable water supply reservoirs, and major production wells.

Educational materials and a regional workshop were provided for 70 Highlands stakeholders in April 2002. This “lessons learned” workshop provided a summary of the methods and findings of this and the other Land Conservation Projects. This regional workshop was a public forum open to all Highlands stakeholders for discussion and networking, to improve communication and cooperation on a regional basis.

The outcomes include a study of the impact of development on the headwaters, identification of critical factors in water quality degradation, methods to derive water quality standards, and sample ordinances that protect potable water supply and aquatic environments.

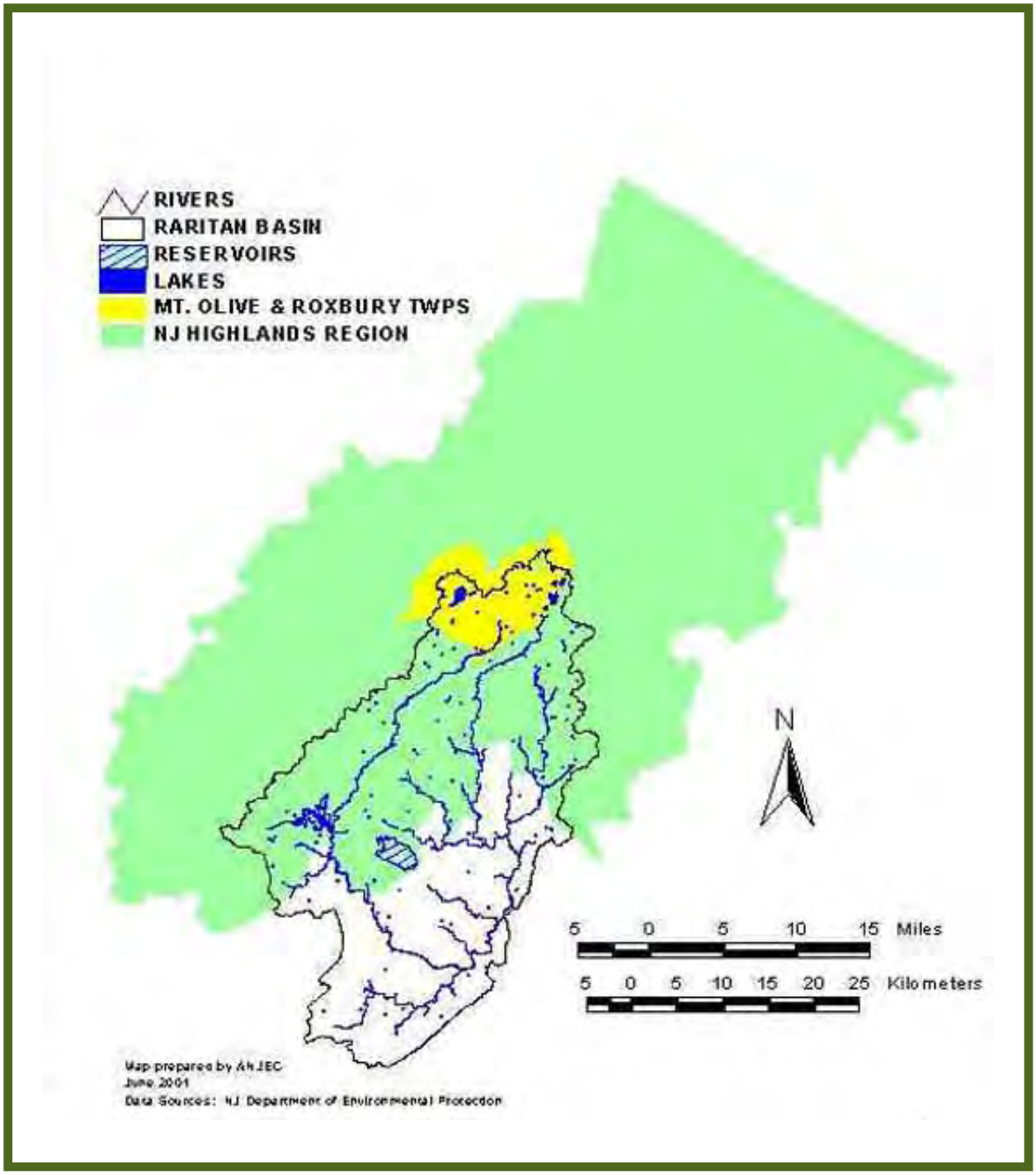

Figure K-5. Land preservation and water supply project area. In Morris County, New Jersey, Budd Lake and the underlying aquifer in Mount Olive Township, and Drakes Brook in Roxbury Township, are representative examples of Highlands resources that are under intensive development pressure and need to be protected.

New York - New Jersey Highlands Regional Study: 2002 Update

NA-TP-02-03